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RHINOLOGY IN CHILDREN. RESUME OF AND COMMENTS ON THE LITERATURE FOR 1939.

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The literature of this subject as contained in prominent journals in 1939 has revealed a greater number of articles exclusively devoted to rhinology in children than appeared in 1938. The same 10 journals are reviewed which were reviewed in the referat of 1938. No comment is made on articles from the totalitarian countries. It has been thought that where free thought and free expression of thought are not permitted the quality of the articles will be questionable. Truth must be followed for its own sake. Some years ago no careful reviewer would have dared to pass over the scientific publications of Germany. It will probably be a long time before publications can be reviewed from that country with any confidence that the literature is trustworthy.

The articles abstracted have been roughly classified. For the convenience of the reader, headings are given to the various sections.

GENERAL ARTICLES ON ACCESSORY SINUS DISEASE IN CHILDREN.

Culpin¹ makes the pertinent suggestion that the term "accessory sinus disease" is more accurate than the term "sinusitis" when referring to children. He points out that the three cardinal conditions present in inflammation are swelling, redness and pain, and that in medical terminology the affix "itis" indicates inflammation. Actual sinusitis in children is a comparatively rare condition. Years of practice

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have impressed upon him how common is accessory sinus disease.

Miller² declares that every acute cold is potentially an acute sinusitis. In children the acute exanthemata are often accompanied by severe acute sinusitis, which later leads to chronic involvement of the sinuses.

Home treatment as a rule is sufficient in acute sinusitis and usually falls to the lot of the pediatrician or family practitioner. Adequate ventilation and drainage are important and should be accomplished by frequent use of astringent drops or sprays. Frequent use of inert liquid petrolatum drops in young children is contraindicated because of the danger of producing pneumonia. Only in the presence of some grave complication should any surgical procedure be undertaken in acute sinusitis, and it should be as conservative as possible.

The simple drainage of a subperiosteal collection of pus by incision through the periosteum is usually adequate. [A subperiosteal collection of pus in sinusitis is rare in children.—Ed.]

The ethmoidal labyrinth should never be attacked by the intranasal route in children because the possibility of meningitis is too grave. [Very occasionally there are conditions in which the ethmoidal labyrinth must be attacked in childhood and I have never known meningitis to follow—but this is possibly because the surgery was conservative and not drastic.—Ed.]

Unfortunately too many cases of acute sinusitis pass insidiously to the subacute and chronic stage, the patient being discharged as cured.

The prognosis of chronic sinusitis in children is better than in adults, provided proper treatment is given. The treatment should be persisted in over a considerable period and a child should be observed periodically for several years before he is discharged as cured of chronic sinusitis.

Birdsall,³ in a long illustrated article, covers a consecutive series of 80 cases of sinusitis in children. He observes that the nasal sinuses should be infected as the result of the same or similar etiological factors as those which cause otitis

media, and yet in a public clinic the number of children suffering from chronic suppurative otitis media usually greatly exceeds those attending for the treatment of nasal sinus infection. This is accounted for by the difference in the symptomatology and clinical signs of the two conditions.

It is because nasal sinusitis is usually insidious in its onset, visual inspection of the actual structures affected is impossible, symptoms produced can be accounted for in various ways, and there is no obvious disability of any special function and it rarely leads to dangerous or fatal complications.

The prominent symptoms were such that these children did not primarily come up to the Ear, Nose and Throat Department.

The 13 most prominent symptoms found in the case histories are tabulated, the most frequent of which, in the order of incidence, were: nasal obstruction, cough, frequent colds, rhinorrhea, pain, throat symptoms. These are all discussed.

Regarding the etiology he states that in children, sinusitis is insidious in its onset or else the early symptoms are unnoticed, only one case of acute sinusitis being seen in this series of 80 cases. In only 13 cases was a definite specific illness found to have preceded the symptoms of sinusitis, and in seven of these the onset was traced back to an attack of whooping cough. Probably the common cold is the most frequent etiological factor and it would be advisable always to treat colds in children with nasal alkaline lotions or with ephedrine to relieve obstruction.

Careful consideration is given to the signs observed on clinical examination. He found that mucopus in the anterior portion of the nasal cavity was the most frequently observed sign, being found in 42 cases, and he thinks that a collection of mucopus in the anterior part of the nasal cavity must have originated in the nasal sinuses because an infective purulent rhinitis confined to the mucosal lining of the nasal passages alone probably did not exist.

He found significant changes in the appearance of the nasal mucous membrane in 34 of the 80 cases. The main types of pathological change were excessive pallor, excessive

redness, and shrinking or pseudoatrophy, which may proceed to actual atrophic rhinitis.

He notes the comparative frequency of nasopharyngeal discharge; however, in 11 cases there was no associated anterior rhinorrhea. The anterior group of sinuses appeared to be much more commonly involved in childhood, and he thinks that the explanation of this is the earlier development of the antra and ethmoid cells.

He points out that in a completely opaque antrum it is difficult to deduce the condition of the lining membrane, and in some he injected lipiodol and demonstrated that the lining membrane was greatly thickened.

Recently acquired sinusitis in children is readily cured by the bodily resources if aided by simple measures such as the relief of congestion by dilute ephedrine in saline solution.

Regarding the rationale of treatment, he has the following to say. If an infection has established itself within a nasal sinus, its eradication is brought about by: the exudation of serum and leukocytes, plus mucus, and the removal of this mucopurulent exudate by the action of the ciliated mucous membranes. The second of these requires the presence of adequate air; therefore, the effective action of the cilia can be interrupted: 1. by the blockage of the airway through the nasal cavity; and 2. by the blockage of the entrance of air into the sinuses. After a sinus has been prevented from draining for a long time, additional factors in preventing drainage are: 3. increased viscosity of the contents so that ciliary activity is inadequate for their removal; or 4. degeneration of the ciliated epithelium. The treatment of sinusitis, therefore, should be directed to the correction of whatever adverse factor or factors are preventing the natural process of cure. [The consideration of these points by the pediatrician should help him understand that he cannot treat nasal sinus infection unless he can see well enough inside the nose to know with what he is dealing. — ED.]

The ventilation of the sinuses is provided by: relieving the swelling of the lining membrane, which may be occluding the ostium, and diluting secretions which are often too viscid to be removed by ciliary activity.

In this series the majority of the cases were treated by ephedrine replacements. The routine treatment adopted was to perform replacement at weekly intervals and to prescribe the use of 0.5 per cent ephedrine in saline drops daily. In more advanced cases the treatments were carried out twice daily.

In very few cases was it impossible to carry out the treatment; children of 3 years usually being quite amenable. The skill of the nursing staff contributed largely to the good results obtained; 10 children were easily treated within half an hour.

The successful application of the method in hospital practice is greatly assisted by performing the treatment on groups of children, treating the more confident children first so that the nervous children realize that the ordeal is not painful but is rather amusing. [These are useful hints for the many rhinologists who have heavy clinics. — ED.]

The results were that in 34 cases the symptoms and signs of sinusitis were completely relieved after a course of replacement therapy. The average time required to effect a cure was one month and the good results were found to be lasting in such cases as could be followed up over a considerable interval. In 16 cases, antrum lavage was carried out on both sides in addition to the ephedrine replacements. In nine cases where conservative treatment failed, antrostomy was performed. They were all cases of advanced sinusitis; the average duration of the disease in these cases being five years. Five of the six have remained free of symptoms for over six months. He points out that in two cases the Caldwell-Luc method was used and that the risk of damage to the teeth germs is probably much less than has been supposed.

*The Lancet*¹ editorially comments on Birdsall's article. It draws attention to the fact that 33 of the 80 children had undergone tonsillectomy without benefit; indeed, the symptoms were often attributed by the parents to this operation, though they had probably existed before. This does not support the view sometimes held that the course of a child's sinusitis may be favorably influenced by removal of tonsils and adenoids. It is, on the contrary, an unfortunate error to perform this operation for symptoms due in fact to sinusitis.

Faier² concludes that the aim of treatment in sinusitis in children is to obtain ventilation and drainage by the simplest method possible.

The Section³ of Oto-Rhino-Laryngology of the British Medical Association discussed this subject in July, 1939. The following extracts from the proceedings are given to indicate trends of thought in the British Isles.

Dr. Douglas Guthrie remarked that the importance of sinusitis had only recently been recognized. There was a surprising frequency of sinusitis, as revealed by routine clinical examination or at necropsy. Nasal discharge, usually post-nasal, was the commonest symptom. Operation was seldom necessary; but, if it were, should be of radical rather than intranasal type. An answer was given to critics of the radical procedure.

Mr. James Crooks agreed that acute suppuration in children demanding treatment was not common; chronic infection was frequent. The antrum, which was retaining products of inflammation, should be washed out, and this could be done satisfactorily under local anesthesia, even in young children, with very good results. In more severe infections, where granular pus was present, operation might be necessary. Intranasal antrostomy gave disappointing results, and he now preferred the radical operation.

Mr. J. G. McLaggan emphasized the need for avoiding operation in cases of allergic sinusitis. Any operation in such cases must be restricted to maintaining a nasal airway. Mr. J. H. Otty said he found the results of intranasal operation bad.

Mr. J. Adam stressed the importance of treating sinusitis in children to avoid the later development of atrophic rhinitis and bronchiectasis. He asserted that most allergic cases in children would clear up on a milk- and sweet-free diet by the administration of calcium and vitamins and by hydrotherapy. Dr. I. S. Hall maintained that the most important factor in treatment was an adequate airway, and in his experience the restoration of this, by removal of adenoids, was all that was necessary.

Chipman and Collins⁷ declare that there is a close relationship between accessory sinus disease, pneumonitis and bron-

chiectasis, and that a more accurate diagnosis of infection of the sinuses should be made early in life and every effort made to provide adequate treatment. They find it is difficult to evaluate the relationship of sinusitis in tuberculosis or the influence of a pre-existent upper respiratory infection as a factor in the cause of a breakdown.

They state that for many years the medical staff of the St. John Clinic for Tuberculosis encountered a group of cases characterized by symptoms suggestive of tuberculosis but found on examination to be nontuberculous infection, usually associated with sinusitis. The patients presented themselves with a definite symptom complex consisting of fatigue (often intensive and seemingly out of proportion to their physical appearance), some loss of weight, a throaty or clearing cough, loss of appetite, headache and a persistent low grade fever. With these symptoms, there was a history of frequent colds in the head and chest that seemed to merge into one another over a period of three or four months, especially in the fall and winter. They had cough and sputum that persisted throughout this period. During the seven years from 1931 to 1938, 4,005 new patients were examined in the tuberculosis clinic; of these, 352 showed definite evidence of sinusitis.

The arguments for and against considering that the nasal accessory sinuses act as foci of infection in arthritis is ably argued by Williams and Slocumb.⁸ The authors review certain works representative of the opinion of those who are strongly convinced that sinusitis is an important etiologic factor in infectious arthritis. Then they quote the opinions and evidence of any opposite point of view. From clinical observation one can occasionally find a sinus acting as a focus of infection, but since this is so rare an occurrence one might, unless careful examination and conservative investigations reveal evidence of such a relation, consider it non-existent. Anderson was greatly impressed with the number of instances in which, on the basis of X-ray evidence of suppurative disease of the paranasal sinuses, an operation destructive of the physiologic function of the nose was done without subsequent benefit to the patient.

The authors, in an attempt to discover what validity might be present in these two opposite opinions, resolved to study

100 cases of infectious arthritis. The patients included in the study had infectious (atrophic, rheumatoid) arthritis. Most of the patients had chronic infectious arthritis and showed evidence of inflammation of synovial and periarticular tissues, X-ray evidence of atrophied bone and narrowing of the joint space, limitation in range of movement, with deformities and ankylosis of some of the affected joints. A few of the patients had subacute inflammation of the synovial and periarticular tissues.

The authors give in praiseworthy detail their method of investigation of the nose. At the end of this, they state investigation of the physiologic characteristics of the sinuses was not attempted; they have not found that attempts at especially refined methods of diagnosis have yielded worth while clinical results. If cysts in the antrum alone were reported by the Roentgenologist, their presence was ignored, as Pattee demonstrated by culture of the aspirated contents of such cysts that they are sterile.

In 20 cases in the whole group of 100, clinical investigation yielded definite evidence of suppurative disease of the paranasal sinuses. Of these 20 cases, 19 were in the group of 42 in which positive Roentgenologic evidence was obtained; one case in which suppurative involvement of the sphenoid and the posterior ethmoid sinuses were found, the results of Roentgenologic examination of the paranasal sinuses were negative. In 17 cases in which Roentgenologic evidence of sinusitis was obtained, clinical investigation did not yield evidence of sinusitis. In six cases in which Roentgenologic evidence of sinusitis was obtained, the examination was reported incomplete. In three cases in the group of 20 in which clinical investigation had yielded evidence of sinusitis, the removal of infected teeth or local treatment of the nose apparently eradicated suppurative disease of the paranasal sinuses, but in none of these cases was a favorable effect in the course of the arthritis noted.

In the group of 20 cases there were two in which evidence of sinusitis was obtained on clinical investigation and in which, in their opinion, the presence of cardiac complications contraindicated operative intervention.

In 15 cases operation directed toward eradicating infection in the paranasal sinuses was advised. Of the 15 patients, 12

were operated on at the Mayo Clinic; three refused surgical therapy.

Four of the patients reported almost complete relief from arthritic symptoms within two weeks after the operation on the paranasal sinuses, and after two years they reported that arthritic symptoms had almost ceased. In seven cases in which an operation on the sinus alone was performed, there were apparently no other foci of infection. Two of the patients experienced almost complete relief from arthritic symptoms within two weeks after operation on the paranasal sinuses and were still in good health after two years. A third patient reported almost complete relief from arthritic symptoms within two weeks after operation, but after six months the symptoms began to return, and at the end of two years the arthritic symptoms were as severe as, if not worse than, they were before sinusotomy. It is of interest to note that if improvement did not appear within the first two weeks after surgical removal of a focus of infection, none appeared subsequently.

Although in this unselected group of 100 cases of infectious arthritis, 20 cases of clinically proved sinus disease were found, the results experienced by the 12 patients who were operated on do not support the conclusion that sinusitis is the principal focus of infection in cases of infectious arthritis. If disease of the sinuses is found, an attempt should be made to eradicate it, but too optimistic an outlook as to the results of this type of therapy should be avoided. It would seem to be definitely an error, however, to assume that the sinuses can be ignored as possible foci of infection in cases of infectious arthritis.

Many careful but very conservative specialists sincerely doubt that the sinuses can act as foci of infection. Their consideration is directed to the following report from the Royal Society of Medicine.⁹

Dr. Bedford Russell in discussing a paper by Dr. Rambaud, of Paris, said he had been much interested in the cultures obtained by subepithelial examination in the sinuses. *It must not be thought that there was no infection merely because the sinus had been washed out and nothing could be grown from the fluid* (italics by the Ed.). Some of Dr. Rambaud's

work in that connection has been confirmed by workers at St. Bartholomew's Hospital, where specimens of the mucosa were steeped in 1 per cent perchloride of mercury for half an hour so as to sterilize the surface. They then obtained a copious growth of hemolytic streptococci in one case, in one case pneumococci, and in another case streptococcus viridans.

Jones and Mote¹⁰ report on the clinical importance of infection of the respiratory tract in rheumatic fever. Most of the data presented were collected from clinically observing 749 patients with rheumatic fever for approximately one year. They conclude that a close relationship exists between acute infections of the upper respiratory tract and the first attacks of rheumatic fever and recurrent rheumatic fever as well.

Infections of the respiratory tract preceded 58 per cent of the first attacks of rheumatic fever. On the other hand, more than one-third of the first attacks were apparently clinically spontaneous attacks of rheumatic fever; however, serologic evidence indicates that a hemolytic streptococcus infection was associated with most of the first attacks of rheumatic fever, whether or not there were preceding symptoms involving the respiratory tract.

In patients in the inactive stage of rheumatic fever, sore throats and colds commonly precipitate recurrent rheumatic fever. In such patients sore throats are followed by recurrent rheumatic fever in approximately one-half of the instances, and almost one-third of the colds are followed by recurrent rheumatic fever. In general, regardless of the age of the patient, the chance of a recurrence subsequent to an infection of the respiratory tract decreases as the period of the inactive phase of the disease increases.

Dr. W. P. Whaley in discussing the paper noted that the result of poor adenoid surgery cannot but increase the potential field of response to upper respiratory infection. Dr. William B. Stroud said: "In treating these children with latent rheumatic fever we have a job similar to the treatment of active tuberculosis in a reverse manner; that is, those who come in contact with cases whose sputum is positive for tuberculosis should be protected from infection, whereas we must protect children or young adults with inactive rheumatic fever from those around them who are carrying latent or active infection, especially in the nose and throat."

Rackemann and Weille¹¹ discuss nasal sinusitis and asthma. They continue their interesting idea that asthma may have a cause different from allergy. They state that, whereas allergy is often an adequate explanation of asthma, there is reason to think that it is only one of several causes which can precipitate the asthmatic syndrome.

The relation of the nose and throat to asthma is important for two principal reasons: 1. Lesions of the sinuses and polypi in the nose are so common as almost to be expected in cases in which asthma has become severe. 2. In the presence of a lesion, it is always tempting to both physician and surgeon to advise radical operative treatment in spite of abundant evidence that results are not often good.

From various figures they conclude that one can say that in asthma, sinus disease is common, but that in sinus disease, asthma is only one of numerous complications. To have asthma without sinus disease is unusual, but to have sinus disease without asthma is common.

COMPLICATIONS OF ACCESSORY SINUS DISEASE.

Williams¹² writes that orbital cellulitis is most frequently due to disease in the paranasal sinuses, and this is true when it occurs as a complication of scarlet fever. Since over 90 per cent of the patients with scarlet fever are children under age 10 years, it would be expected that infection of the ethmoid sinuses would be the prime producer of orbital cellulitis; such is the case. Maxillary sinusitis may produce orbital cellulitis especially of the lower lid in young children. Infection from the sinuses may enter the orbit by direct extension with necrosis of the bone, through a dehiscence in the bony wall, along the walls of the vessels or by thrombophlebitis.

There are three stages in the development of orbital cellulitis: 1. edema of the lids, frequently confined to the inner half and more marked in the upper lid if the frontal or an ethmoid sinus is involved, and in the lower lid if the maxillary sinus is responsible; 2. marked edema of the lid with closure of the palpebral fissure, and exophthalmos usually without limitation of movement; 3. evidence of the formation of an abscess with or without limitation of motion. There may be evidence of pointing, but when the condition

is under observation surgical intervention is usually resorted to before pointing appears.

The treatment depends on the degree of involvement. In cases in which there are conjunctivitis, simple edema and cellulitis without the formation of an abscess, it is always conservative. The treatment consists of shrinking the nasal mucosa under the middle turbinate with 1 per cent ephedrine or cocaine, or a combination of the two, and aspiration of the nasal cavity by suction. Several times daily. Cold compresses.

When the cellulitis continues to increase instead of decreasing after 24 to 48 hours of conservative treatment, some surgical intervention is necessary. For children whose ethmoid sinuses or antrums are involved, removal of the anterior tip of the middle turbinate and opening of the ethmoid cells, together with intranasal antrostomy when there are symptoms of antral disease, will usually be sufficient for prompt relief of symptoms.

In children the frontal sinuses are usually small and seldom involved enough to require surgical drainage. In the cases of scarlet fever in which surgical intervention was resorted to, only sufficient was done to establish good drainage. In this series of 68 cases no extensive surgical intervention was necessary.

Yaskin,¹³ in a summary of 20 years' experience of neurologic complications of infections of the paranasal sinuses, gives the case report of an abscess of the right frontal lobe first manifesting itself after recovery from sinusitis in a boy age 11 years. Drainage was followed by recovery.

TREATMENT OF ACCESSORY SINUS DISEASE.

Parkinson^{14, 15} in two articles presents a way of treating accessory sinus disease in children — and, incidentally, chronic colds in children — which is of distinct value to all rhinologists, pediatricians and general practitioners. The article in the *Journal of Laryngology and Otology* is adequately illustrated by good photographs.

His simple technique for the treatment of infection of the nasal sinuses consists in the use of a certain posture of the head and the instillation of a drug in physiologic vehicle.

Adequate aeration and free drainage follow, with a minimum of trauma, chemical and/or physical.

The technique is as follows: Preliminary shrinkage is first obtained by the use of an isotonic solution of ephedrine sprayed from an atomizer. After five to 10 minutes of waiting, the patient is placed in the lateral head-low posture, at which time ephedrine, in Locke's or Ringer's solution, or its equivalent, is instilled into the dependent side of the nose. Infants and small children can be held over one's lap. The posture is maintained for three to five minutes. The head is then rotated to a face down position to permit the nasal contents to escape from the nostrils. Then the opposite side of the nose is treated in similar fashion.

This technique is easy, practical and comfortable, with few if any untoward effects, and can be performed anywhere because no special apparatus is necessary.

Kennedy¹⁶ writes on the treatment of the "common cold" in infants and children. He concludes by condemning the widespread practice of the indiscriminate instillation of drops into the noses of young children.

Shea¹⁷ has a long article on the rational treatment of sinusitis in children, which discusses points too numerous to detail here. The value of the article is enhanced by the discussion which followed — for the eminent discussers disagree with the author and with one another.

Those interested in the treatment of accessory sinus disease by short wave diathermy are referred by Hollender,¹⁸ and to the textbook written by Bierman.¹⁹ Note that the latter takes the same stand as other conservative observers, that the primary action of the current is essentially due to the heat developed and that the so-called nonthermal or specific effects are still to be proven.

Hodges and Snead²⁰ write on Roentgen therapy of carefully selected sinus infection. The writers seem enthusiastic about the results they can obtain by irradiation in the treatment of certain types of infection in the nasal accessory sinuses. As a rule the longer the duration of the infection the poorer the results obtained. They stated they had treated a number of cases in whom symptoms had been present for several years, usually with hyperplastic sinusitis, with

marked clouding of the ethmoid and marked thickening of the membrane in the antrum. They state that the majority of these cases also responded to irradiation.

DIAGNOSIS OF ACCESSORY SINUS DISEASE.

Shambaugh²¹ describes the use of displacement suction for the diagnosis of obscure low grade chronic infections of the ethmoid sinuses. He has used iodized oil comparatively little, partly because of the added cost to the patient of additional Roentgenograms and partly because he has not been convinced of the reliability of failure to fill or of delayed emptying time for the diagnosis of infection. He used the Proetz method to promote drainage — if he gets pus from the ethmoid sinuses he has made the diagnosis of infected ethmoid cells.

His procedure is briefly as follows: A Roentgenogram is taken to rule out infection of the maxillary, frontal or sphenoid sinuses, and if any of these appear infected they are irrigated. The nasal passages, vestibule and especially the nasopharynx are then carefully cleansed of any adherent secretions. With the patient's head hyperextended in the Proetz position, the nasal passages are filled with 0.25 per cent ephedrine in physiologic solution of sodium chloride. Alternate suction and release of suction is applied from four to six times in each nostril, and, if frank mucopus is obtained or is blown out into the towel when the patient sits up, the diagnosis of ethmoid suppuration is made. The importance of removing any mucopus from the nose, nasopharynx or maxillary sinus before carrying out the displacement suction is self-evident. In certain cases there is no immediate escape of mucopus, but an hour or two later the patient will experience a nasal or postnasal discharge of a considerable quantity of frank mucopus, and this is equally diagnostic of a chronic suppuration of the ethmoid sinuses.

The author is impressed by the large number of low grade chronic suppurative ethmoid sinuses that would otherwise have been overlooked.

THE SURGICAL PATHOLOGY OF NASAL SINUSITIS.

Semenov²² draws conclusions from the histological study of sections from various types of sinusitis and certain allergic

cases. Thickening of the periosteum of the sinus in excess of 2 mm. is associated with deep-seated degenerative changes in 50 per cent of the cases. Seventy-two per cent of the cases were purulent sinusitis — the remainder were non-purulent, hyperplastic, polypoid and cystic degenerations. Manifest allergic sinusitis occurred in 17 per cent of the cases. The allergic membrane is prone to infection and resistant to treatment. Degenerative changes are greater in allergic sinuses. Mixed infection was present in 80 per cent of the cases. Exudative sinusitis usually responds to conservative treatment but degenerative changes which are irreversible in character require radical treatment.

NASAL ALLERGY.

Barnett and Carnahan²³ emphasize that the constitutional disturbance of allergy is the mutual concern of every rhinologist and every physician who treats the sick child.

They give an excellent description of "colds" that are not "colds." They assert that routine smears of nasal secretions should be examined to arrive at accurate diagnosis of nasal conditions. The demonstration of eosinophiles corroborates the diagnosis of nasal allergy. The technique is simple and should be carried out repeatedly in the office of every rhinologist and every physician who cares for a child with nervous disturbances.

They point out that the value of this laboratory routine cannot be overemphasized. It is well to note that the volume of the smears in routine practice is too great to permit dependence on a clinical laboratory; moreover, the tests are of more clinical value if carried out in a physician's office, where the results may be closely compared to the progress of the patient.

Piness and Miller²⁴ reiterate their standpoint of 15 years ago that allergy is a nonsurgical disease of the nose and throat. They take much pain in showing that both the pediatrician and the rhinologist have been at fault in mistakenly removing tonsils and adenoids in cases where the underlying trouble was nasal allergy. The largest of chronically enlarged tonsils are due to allergy and the regrowth of lymphoid tissue in the tonsillar fossae after tonsillectomy is as characteristic

of allergy as the originally enlarged tonsils, whose size alone so often seems to have been the indication which led to their removal. Lymphoid hyperplasia is one of the distinctive features of allergy.

This valuable article suggests that the physician should study the child to discover his physiologic deviation from the normal. As the child's body mineralization is improved and his physiologic reactions become more stable, the respiratory infection and other symptoms which appear in the form of allergy disappear and the tonsils subside behind the tonsillar pillars.

ANATOMY.

Simon,²⁵ from the study of 102 antrums from cadavers, concludes that: the so-called maxillary ostium in the majority of cases is a canal; in a group of 110 natural ostiums, 82.7 per cent were canals of 3 mm. or more in length, and the average length was 5.55 mm. — on the other hand, the accessory maxillary ostium is practically always an orifice or ostium.

In reporting a case of congenital occlusion of the left posterior nares, Derek Brown Kelly²⁶ makes two valuable observations: 1. A newborn infant with bilateral choanal atresia suffers from considerable difficulty in breathing. Its instinctive attempts to breathe through the nose result in severe dyspnea, and even cyanosis, which is relieved only when the mouth is open to cry. A cycle of attacks of dyspnea alternating with fits of crying and relief of symptoms is thus established and forms a typical clinical picture. Sucking and, consequently, nutrition are interfered with. 2. Unilateral cases are rarely recognized early in life. It is only when the patient is old enough to realize that one nasal passage is blocked and there is a troublesome discharge of mucus that relief is sought. Mistakes in diagnosis consequently are not infrequent.

Cottle²⁷ discusses the histologic aspects, causes, symptoms and treatment of deviations of the nasal septum. He concludes that frequently nasal obstruction and chronic discharge are the result of septal deviation; that often non-surgical treatment is needed and is adequate; that occasion-

ally surgical measures are indicated; and that the type of operation which is appropriate to an adult is unnecessarily radical for a child in all but the rare instances of extreme deformity.

MENINGOCOCCIC CORYZA.

Henry and Kuhn²⁸ report three children, age 15 months, 2½ years and 4 years, each of whom had a history of slight elevations in temperature, profuse nasal mucopurulent discharge and a markedly pale edema of the mucous membrane, but only slight inflammation of the nose. Smears and bacteriologic study revealed practically a pure culture of Gram negative diplococci which were agglutinated by meningococcus antiserum in a dilution of one in 320. Cultures taken from the mother on two occasions did not yield meningococci.

For all three children, sulfanilamide was prescribed and they were kept under close observation and in isolation. At no time did any symptoms simulating meningitis appear. Six days after treatment had been instituted, the children were all clinically well. Repeated cultures were taken after this time from the nose and nasopharynx, and meningococci were not found.

FOREIGN BODIES.

Canuyt and Gunsett²⁹ report an unusual foreign body (rubber tip of an arrow) lodged in a child's nasopharynx. A radiograph of the cavum showed no pathological shadow. A tomography, on the contrary, showed a distinct oval shadow. The writers draw attention to the value and importance of tomography in the diagnosis and localization of certain foreign bodies.

PHARMACOLOGY.

Galgiani, Proescher, Dock and Tainter³⁰ come to the unavoidable conclusion that adrenalin and similar compounds are unsuitable as local applications to the upper respiratory tract except for brief periods, and that their repeated use in chronic disease is therapeutically unsound. This is in agreement with the clinical observation of many laryngologists concerning the patient complaining of "nasal catarrh," who

had used one of the proprietary preparations containing adrenalin, ephedrine or benzedrine for a long time, and with the cure that results when it is discontinued.

Although ephedrine²¹ is perhaps one of the most important drugs in the treatment of acute and subacute nasal conditions, it must be used with caution in chronic nasal disease. Thus, for example, in vasomotor rhinitis and perennial nasal allergy, in which there is chronic nasal obstruction and the need for relief is constant, ephedrine should be used with caution, for it, as do similar drugs, *may act as a sensitizing agent when used indiscriminately* (italics by the Ed.).

A transient vasoconstriction is followed in many instances by a prolonged vasoparalysis; sneezing, a watery discharge, and itching become prominent complaints, and the original disease is much aggravated and prolonged by the very medication intended to relieve it.

As shown by Proetz and others, ephedrine is best used in physiologic solution of sodium chloride rather than in an oily preparation. It is also well used in weak solution, from 0.25 to 0.5 per cent, in the displacement method of treatment.

The use of colloidal silver tampons²² in the treatment of chronic sinusitis is practiced extensively by otorhinologists in this country. In a recent questionnaire it was shown that approximately 90 per cent of the specialists used some silver salt in treating diseases of the ear, nose and throat. Although practically every silver preparation has been used, the favorite one is mild protein silver, usually in 10 per cent strength.

Colloidal silver preparations are said to be bactericidal, sedative to inflamed mucous membranes, and stimulating to reparative processes. These are debatable points. It is true, however, that the colloidal silver preparations are mildly astringent, and it is partly due to this factor that they give symptomatic relief.

The more ardent proponents of the silver tampon treatment have formulated a routine of tampon insertion, designating types of cotton, applicators and position of the tampon. The latter, the "sphenoid" and "infundibulum" direction, is said to bring the medication into contact with most of the sinus ostia and is considered by some to be abso-

lutely indispensable to the full success of the procedure. The tampons are left in place from 30 minutes to an hour and after removal the nose is flushed with some cool irrigating fluid.

Despite the popularity of this form of treatment, there are many capable rhinologists who feel that it has no peculiar advantages over many other conservative methods of treating chronic sinusitis.

Bacteriostatic and bactericidal power of mild protein silver as investigated by Hilding, Cannon and Walsh, is so slight as to be of little clinical importance. The astringent effect can be achieved by many other drugs without too elaborate technique of medication. Though mild protein silver has not been shown to be harmful to ciliary activity, possibility of argyria, local or general, even though infrequent, must be kept in mind when one is using silver salts extensively.

Bricker and Graham³³ point out that the enthusiasm with which sulfanilamide is being used in the treatment of infections of all kinds has tended to minimize a consideration of the possibility of any harmful effect of the drug.

The authors experimented with animals and reached the conclusion that sulfanilamide given to dogs in doses comparable to the therapeutic doses used by human beings has an inhibiting effect on the healing of uninfected incised wounds.

ATROPHIC RHINITIS AND OZENA.

Eagle, Baker and Hamblen³⁴ have studied the effect of treatment of atrophic rhinitis by estrogenic substances. Inspection of the nose revealed certain marked diminution or complete eradication of crusts in all 14 cases in which the study was completed, and in no instance was the odor characteristic of the disease detectable. The only changes noticeable in the mucosa were a slight increase in hyperemia and a smoother surface. The authors are unable to state whether the patients' noses were free of crusts because of the more frequent irrigations or because of the estrogenic therapy. The impression was that the surface epithelium and the sub-epithelial glandular system contain more mucous cells after treatment than before.

Jeffcoate³⁵ presents an article on estrogenic hormone therapy which should be read by every physician before he administers estrone. Estrogens are advised for skin diseases such as acne, hyperpiesis of all types — diseases of the eye and even urethral incontinence! Newborn babies do not escape from its administration, for it is claimed that premature babies thrive better if 0.05 mg. of estrone is added to their diet each day.

It would seem that estrogenic substances are in danger of being advertised as a "cure-all," and it is not surprising that the results of estrogenic hormone therapy for these multitudinous conditions and symptoms are very variable and on the whole disappointing. As a rule it is valueless unless the condition in question is associated with puberty, the menopause or some endocrine disturbance in which the diagnosis of a deficiency of estrogenic hormones can be reasonably established.

Then he discusses the untoward effect of estrogenic hormone therapy. The estrogens are essentially growth-promoting in their effects, and it was at one time feared that their extended use might result in the development of neoplastic change. It is of interest to note that in a series of 43 patients treated for vaginitis, etc., three developed carcinoma cervicitis some months after estrogen therapy. It should be stated here that there is no definite evidence that the hormone administration was the cause of the neoplastic development. These substances are definitely contraindicated in the presence of any "precancerous" lesion.

ENDOCRINES.

Cody³⁶ presents a study of the relation of endocrine dysfunction and otolaryngeal disease: 1. diseases of the throat and nose have an effect of producing endocrine disorders; and 2. an endocrine defect is an etiologic factor in diseases of the ear, nose and throat.

His conclusions are: 1. Foci of infection in the tonsils and paranasal sinuses may occasionally cause a dysfunction of the thyroid, pituitary body and parathyroid, and suppress the action of insulin with systemic consequences. 2. A dysfunction of the thyroid, pituitary, parathyroid, pancreas or ovary

may produce a pathologic condition in the nose, larynx or ears. 3. While these dysfunctions seem not to be a common occurrence, they are of sufficient importance to merit consideration.

OSTEOMYELITIS OF SUPERIOR MAXILLA.

Lacy and Engel³⁷ describe a condition in an infant which simulated maxillary sinus infection but which they conclude was acute osteomyelitis of the superior maxilla.

The latter condition is the subject of an admirably written and profusely illustrated article by Asherson.³⁸ It can be recommended to anyone as a most complete and up-to-date description of the condition.

Acute osteomyelitis of the superior maxilla in young infants presents a typical and constant clinical picture, enabling the condition to be readily identified in spite of the great rarity of its occurrence.

It results from a staphylococcal infection of the pocket of the unerupted deciduous molar tooth, and the adjacent part of the anterior surface of the superior maxilla. Whether the maxilla is involved before the tooth socket or whether the tooth socket is primarily affected cannot be stated with exactitude. Superiorly it extends to the orbit, and anteriorly to the canine fossa, forming an adjacent and continuous abscess in both these regions. This abscess gives rise to the characteristic appearance. Inferiorly the infection spreads to the alveolar process and the contiguous region of the hard palate, in both of which situations swellings and abscesses form. Posteriorly the maxillary antrum is involved. The abscesses in all the situations mentioned, whether they are drained surgically or rupture spontaneously (as usually occurs in a neglected case or when surgical interference is withheld at an early stage) give rise to multiple fistulae. These fistulae are external, buccal, alveolar and palatal. Later, sequestra form and may be spontaneously excluded or be the cause of the persistent fistula until removed by operation. The deciduous molar may be spontaneously excluded.

The external fistula always presents in the same situation, below the inner canthus, through the lower eyelid at its medial part. A late case may present with this fistula already formed.

The lachrymal apparatus escapes involvement.

In the past, acute osteomyelitis of the superior maxilla was looked upon as an orbital abscess secondary to an acute infection of the maxillary antrum; namely, as a case of orbital cellulitis.

Symptoms: The disease may affect infants of all ages, but the majority of these cases occur in infants within the first few weeks of life, up to the twelfth week.

Starting with a feverish attack, the onset is sudden and the characteristic symptoms develop rapidly within a few days. Within 24 hours the eyelids suddenly become swollen and edematous on one side. The eyes become closed, with chemosis of the bulbar and palpebral conjunctivae. There is proptosis with displacement of the eyeball, producing ophthalmoplegia. The eyelids can only be pried apart with difficulty. There soon develops a unilateral purulent discharge, from which the staphylococcus can be cultured. Induration and swelling of the teeth is a prominent feature and may be the first sign of the disease, and may rupture early and produce a fistula discharging pus. Last of all, a palatal swelling develops in the region of the hard palate in juxtaposition with the alveolus. This palatal swelling extends posteriorly the entire length of the hard palate but medially does not extend beyond the midline; the swelling usually ruptures spontaneously anteriorly, close to the alveolus.

If not operated upon, the abscess in the orbit will rupture spontaneously externally through the lower eyelid just below the inner canthus, and give rise to a persistent fistula there. The fistula may close over but breaks down repeatedly. It is not possible to prevent the abscess rupturing externally by draining it through the canine fossa.

Fistulae may also form in the canine fossa, the alveolus and the palate, and these may all occur together in one case.

Simultaneously with the onset and rapid spread of the infection and the onset of these physical signs there are severe constitutional symptoms and signs. The infant is very ill.

A Roentgenogram of the antra of the infant is of little or no value, as it does not show up the small antrum, the unerupted molar tooth in its bud obscuring a possible view.

The meagre information to be gleaned from the Roentgenogram in the initial stage of the illness does not warrant the risk of giving the sickly infant an anesthetic. At a subsequent date, when the question of a large sequestrum arises, a Roentgenogram may be used in showing it up.

The staphylococcus is cultured from the nasal discharge, and from the pus of the orbital and other abscesses. It may be cultured from the blood.

The first or septicemic stage of acute osteomyelitis of the superior maxilla in infants persists for about 10 days. With spontaneous external rupture of the abscess or surgical drainage, the temperature drops and the case passes into a second chronic or indolent stage of fistula formation and sequestration of dead bone. This may last for several months, particularly if adequate and thorough surgical measures are not instituted at an early stage.

The infant may succumb within a few days from septicemia, and possibly bronchopneumonia, or at a much later date from a brain abscess. It is during the acute stage that active treatment in the shape of surgical drainage and constitutional measures is essential if, in a fulminating case, life is to be saved.

The danger to life is present during the first 10 days, during the acute septicemic stage of the illness. The second stage may persist for years.

The author presents an excellent table to indicate the points of difference between acute osteomyelitis of the superior maxilla and orbital complications of acute sinus infection in infants.

When the abscess due to an orbital cellulitis is drained into the nose, the incision heals up and a fistula does not persist. There is never any swelling or fistula formation in the canine fossa, alveolus or palate. These latter features are pathognomonic of osteomyelitis of the superior maxilla.

Prognosis: The mortality would appear to be about 25 per cent.

Treatment: Immediate operation is indicated as a rule when the case first presents, as is usual, with an orbital canine and alveolar abscess already formed.

Operation During the Acute Stage:

1. Drainage of the orbital abscess by an external incision.
2. Counter-drainage through the medial wall of the orbit, through the anterior part of the middle meatus into the nose. A rubber drainage tube is inserted through the external incision down to the orbit, and the external incision is left unsutured.
3. The maxillary antrum is drained by an antrostomy in the inferior meatus.
4. The abscess in the canine fossa and/or the alveolus is incised through the mouth.

As a rule within the first few days of the illness, when the above operation is indicated, sequestrae have not as yet formed and so do not require searching for or removal.

Operation During the Chronic or Indolent Stage: After the first pyrexial or septicemic stage is passed, usually at the end of the second or third week, further operation or operations may be necessary to search for and remove any sequestra which still form and are the cause of a persistent profuse discharge from any one region. Where counter-drainage was not, for any reason, performed at the first operation, it should be performed now.

Details: Very many details are provided by the author of the whys and wherefores of small points in treatment, during operation and after, which will be of great value to the rhinologist in managing a case. Only a few of these are given in what follows.

When the swelling in the canine fossa is exposed, the cheek is retracted and the swelling incised. Any *obvious* sequestrum or sequestrated tooth is removed, but should not be sought for. It will be found that the cavity entered communicates with the external wound and orbit. After the operation is completed, the facial dressing is anchored in position by an adhesive strapping, over which an elastic bandage is applied. The infant is placed on its side so that the affected side lies lower. Secretions draining away tend to flow out of the nose and mouth.

Asherson has not known a case to heal up if counter-drainage into the nose has not been established.

[A most admirably written article. — ED.]

TUMORS.

Collins,³⁹ in a paper on the osseous affections of the maxillary sinus, has a short section on tumors which are dental in origin. Under this he mentions dentigerous cysts.

These cysts arise from the epithelial elements of the enamel organ during the development of the teeth. They are relatively rare, and in the majority of cases the patient is under 15 years. The radiological appearance shows an unerupted tooth or teeth in the centre of a monolocular cyst. Invasion of the antrum may occur in the same way as in the case of dental cysts and the treatment is similar — to obliterate the wall between the cyst and the antrum and to establish intranasal drainage.

Drummond⁴⁰ gives a concise account of adamantinomata, which are tumors which arise from remnants of the enamel organ forming embryonic epithelium. There are seven excellent illustrations accompanying an adequate case report of a girl, age 14 years, who had an infraselar adamantinoma. It shows that three months after the last operation the child was in good health, had put on weight and now took an active part in games. There had been recurrences of headaches since the first operation and breathing had become nasal, but there was no further improvement in the vision of one eye.

Weinberger⁴¹ asserts that nasopharyngeal malignancy may occur at any age, and gives a case report illustrating the early rapid growth and prompt recurrence of a fibrosarcoma of the posterior ethmoids in a young boy.

Among his conclusions he states that it appears from a review of the large experience of others that more and more importance is placed on irradiation, regardless of the classification of the tumor, which is of secondary importance and sometimes misleading in regard to applied therapy. Irradiation is becoming more intelligently and effectively used. The more highly malignant these tumors of the nasal sinuses are, the more reliance must be placed on irradiation.

Capps⁴² reports a small series of apparently well authenticated examples of lymphoepithelioma in the nasopharynx and expresses the hope that in the future its identification, treatment and prognosis may be better established.

In his cases, among early symptoms: 1. deafness was present in five cases; another had altered sensation in the ear on the affected side, and one was deaf on the same side some two or three years before the lesion started; 2. nasal obstruction of a partial nature was present in three cases; 3. swelling in the neck was present in four cases; 4. one case complained of pain on swallowing.

As later signs are found: 1. swellings on both sides of the neck or on the other side when one has been early affected, in three cases; 2. deafness in one and earache in one; 3. nasal obstruction in one; 4. the palate was pushed down in one; 5. double abducens palsy occurred in one.

In certain cases the shortest period between the onset of symptoms and the discovery of the primary growth was three weeks, and the longest, six months.

It is, therefore, of the utmost importance that cases presenting any of the symptoms enumerated above or with neuralgia involving the lower two divisions of the trigeminal nerve should be examined by posterior rhinoscopy at frequent intervals until either the symptoms disappear, or a satisfactory cause is found for them.

The primary tumor is commonly small and sessile, and lies in the lateral wall of the pharynx in the region of the opening of the Eustachian tube. It is pink in color, firm to the touch and may be appreciable to the examining finger only as a hardening in the wall of the pharynx. Ulceration is either slight or absent in the early stages. The older parts of the tumor may ulcerate but submucous extension goes far in advance of the ulceration.

The secondary glands in the neck are "rubbery," hard inconsistently and give the impression of many discrete glands matted together by inflammation.

In the table of his cases he gives one of a boy, age 12½ years, whose early symptoms were nasal obstruction, left — getting thin — and deafness in the left ear. The earliest symptoms occurred two months previously. The lesion was in

the left side of the nasopharynx. The histological report originally gave edematous granulation tissue, inflammatory, and later on was revised to a rapidly growing lymphoepithelioma. Treatment was equivalent of 1,010 mc. hours of radium. He was last seen two and one-half years after original visit, when he was alive and well and nothing was to be seen clinically.

In his series, one case is alive and well after three and one-half years, one just over two years, and both of these had the primary lesion only. The remaining six were all dead within year of being seen.

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IMPAIRED HEARING IN SCHOOL CHILDREN.*††

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This report is based on careful otologic examinations of 1,365 Baltimore school children between the ages of 8 and 14 years, made during the school year of 1939-1940.†† The group is, we believe, a fair random sample of the white children of this age in our community who are attending regular school classes. All children in the third, fourth, fifth and sixth grade classes of six schools (three public schools and three Catholic schools) were examined, providing the parents did not object. There is no reason to believe that the refusals were related to the hearing of the children concerned. No children from vocational schools or from special classes for the physically handicapped are included in this sample.

All examinations, both of physical conditions and of hearing, were made at the hospital, not at the school building. The hearing tests, as well as the physical examinations, were made by the physicians conducting this investigation, not by technicians. Good co-operation was secured from the vast majority of the children.

The thresholds of hearing for 14 tones (32, 64, 128, 256, 512, 1,024, 2,048, 2,896, 4,096, 5,793, 8,192, 10,321, 13,004

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and 16,384 cycles per second) were determined in a "sound-proof" room with a Western Electric Co. 1A audiometer. Masking was used whenever there was more than a slight difference in the thresholds of the two ears. Hearing for spoken voice was tested individually in the "sound-proof" room with the Western Electric Co. 4A, or phonographic, audiometer. The opposite ear was always masked for this test, even when both ears were normal. Each phonographic disc was used for only 100 tests, to avoid possible errors from damaged discs. A 512 d.v. steel tuning fork was used for the Weber, Schwabach and Rinne tests, with masking of the opposite ear for each of the latter two tests.

The physical examination of each child included an inspection of the nasopharynx with a nasopharyngoscope. Only 3 per cent of the children who were brought to the laboratory refused to co-operate in the nasopharyngoscopic examination. This is a much smaller number than we had anticipated. Those who refused this part of the examination are not included in the group of 1,365 children on whom this report is based.

To facilitate statistical studies, a special card of the so-called border-punch type was prepared for this investigation. On it are recorded all the observations made—hearing tests, physical findings, previous history, treatments, etc. Five complete examinations and 10 treatments of a child can be recorded on one card. $8\frac{1}{2}$ x 11 inches in size. The examining physician records the findings directly on the card. The method proved to be much more convenient and practical than the use of separate audiogram sheets and dictated notes; and much less filing space is required than when folders are used.

The analyses that have been made of the observations reveal many interesting facts, only part of which can be presented today. The study is still in progress, and the significance of some of the most interesting observations can be evaluated only after the children have been re-examined for a period of years.

Treatment has been advised for 239 of these children, on the basis of physical findings and hearing tests. For 208, or 87 per cent, the consent of parents and of family physician

has been obtained and treatment of the nasopharynx with radon has been begun by the method described today by Dr. Crowe and Dr. Burnam. To date, 184 of these children have been re-examined from one to six times each, depending on when treatment was begun. Each has had from one to four treatments. The longest time interval since first treatment is now only six months, the shortest is less than two months; therefore, it is too early to draw final conclusions. Already, however, the adenoids of 95 of the 184 children are definitely smaller. The longer the time interval since the first treatment the larger is the percentage in whom the primary purpose of this treatment has been accomplished. The amount of the shrinkage of the lymphoid tissue in the nasopharynx is in many of these treated children truly remarkable. Eustachian tube orifices that were completely overgrown with lymphoid tissue at the time of the first examination are now completely free of any obstruction.

The control group for the effectiveness of treatment consists of 467 children who have had no treatment but have been re-examined three to four months after their first examination. Most of these children also had large adenoids, but only a slight, and in many instances no impairment of hearing. At the second examination the adenoids were smaller than at the first examination in 89 of the 467 children, or only 19.1 per cent, as compared to 51.6 per cent for the treated group, and very few of these in the control group show more than a slight decrease in size.

The changes in hearing that occurred in the two groups, treated and control, will be compared after consideration of the observations made at the first examinations of the entire group of 1,365 children.

Figs. 1 to 4 show the incidence of different types of audiograms in this material. The percentages given in these four figures are based on the total number of ears, since the two audiograms for a child may differ considerably.

The upper line of Fig. 1 shows the average of the audiograms of 57 children (114 ears) with the best hearing, bilaterally. This line may properly be called the normal, or zero, for our conditions of examination. The lower line shows the average of the audiograms of 22 children with the poorest

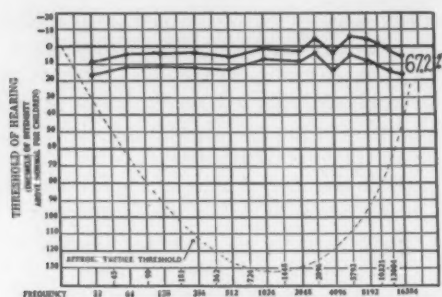


Fig. 1.

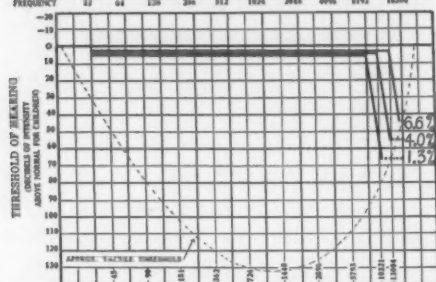


Fig. 2.

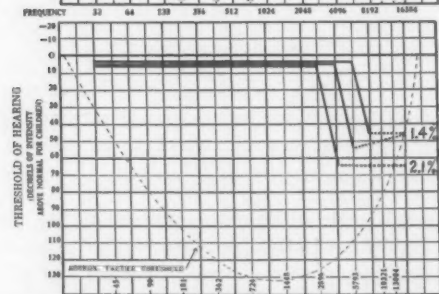


Fig. 3.

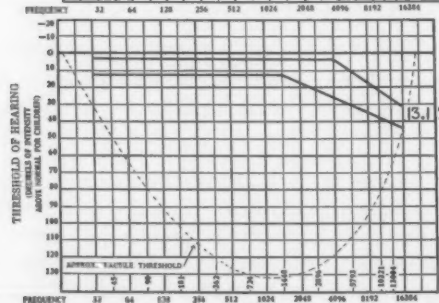


Fig. 4.

Figs. 1 to 4 show the incidence of different types of audiograms in the school children examined.

thresholds of hearing that were included as being in the range of normal. (Most of these 22 children co-operated only fairly in the test, and their thresholds are probably better than the records indicate.)

Two types of audiograms outside the range indicated in the figure are also included in the figure of 67.2 per cent. The inclusion is arbitrary and is done to avoid subdividing the material unduly. 1. If all tones except that with a frequency of 16,384 cycles are well heard and the latter is heard at all (the maximum intensity for this frequency produced by the 1A audiometer is 40 dcb.), the audiogram is included in the group of those with good hearing for all frequencies. 2. If the audiogram shows a "dip" (impaired hearing) for one frequency, but all others are well heard, the ear is included in the group with good hearing.

Note that the figure of 67.2 per cent is for ears; the per cent of children with both ears in the range of what we have called normal is smaller.

Fig. 2 shows the incidence of ears with impaired hearing of the "abrupt" type of high tone loss involving the highest one, two or three frequencies, respectively, produced by the 1A audiometer. With the exception of a few cases with "4,096" or other "dips," all tones up to that of the "abrupt loss" are heard in the range of normal. Hearing for speech is good in all cases. If tested with a 2A or other audiometer that has 8,192 cycles as the highest frequency, all these ears would be in the group termed good hearing for all tones.

"Abrupt" high tone losses, even of the degrees shown schematically in Fig. 3, do not affect hearing for the spoken voice except when in a crowd or in other noisy surroundings. The phonograph test does not detect the impairment.

The number of ears with impaired hearing for high tones of the type that is best described as a "gradual high tone loss," with audiograms falling in the range indicated by the two schematic ones in Fig. 4, is about equal to the total number of those with all the types of "abrupt high tone loss" shown in the two preceding figures. Only about half of those we have classified as "gradual high tone loss" would be definitely detected by tests with an audiometer having 8,192 cycles for the highest frequency, and none of them would be

detected by tests with the phonographic audiometer. Many of these children do complain of difficulty in hearing in a crowd, just as do elderly people with a similar impairment of hearing for high tones.*

Only 4.3 per cent of all the audiograms are of types not illustrated in Figs. 1 to 4. The majority of this small and miscellaneous group show either a slight to moderate impairment of hearing for all tones, including those in the conversational range or an impairment for low as well as for high tones with good hearing for part of the middle range of tones

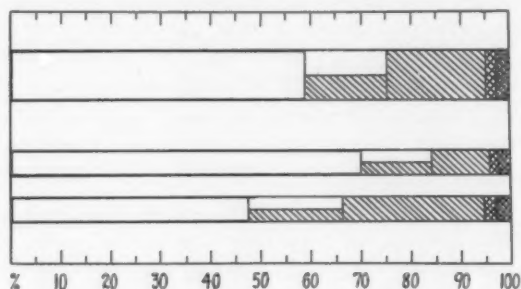


Fig. 5. The three strips of this figure, from above downward, respectively, show the incidence of impaired hearing (1) in the entire group of 1,365 children; (2) in the 693 girls of the group; and (3) in the 672 boys. The symbols used are explained in the text matter, pp. 736 to 738.

As would be expected from the fact that they are attending regular school classes, very few of the children have severe degrees of impairment bilaterally.

The upper strip of Fig. 5 shows, by very broad groups, the incidence of impaired hearing in the entire group of 1,365 school children examined. The unshaded zone, to the left in the figure, represents the children who have good hearing bilaterally for all frequencies, as defined for this study in the discussion of Fig. 1. Even with the inclusion of ears with "dips" and of those with impairment for only the highest frequency, 16,384 cycles, this group constitutes but 58.8 per cent of the children examined; the more rigid requirement for inclusion would reduce this group to considerably less

*It is quite probable that impaired hearing for high tones does unfavorably affect the work of these children in the classroom. The school records of achievement are to be compared with our observations on hearing.

than half of the children examined. These figures differ so much from those found in most surveys of the hearing of children that we wish at this time to call attention to the fact that no previous study has included the testing of thresholds for so many of the high frequencies.

The second zone of the strip, unshaded in the upper half and obliquely hatched in the lower half, represents the 16.5 per cent of the children who have one ear with good hearing for all tones, and one ear with some type of impaired hearing for high tones only. The impairments may be of any of the types shown schematically in Figs. 2, 3 or 4. The next zone, with oblique hatching across the entire width of the strip, represents the 19.8 per cent of the children who have bilateral impairment of hearing for high tones. In other words, nearly one-fifth of all the children examined do not have, with either ear, what is usually regarded as normal hearing for high tones.

Twenty-nine children, or 2.1 per cent of those examined, have, with one or both ears, impaired hearing for other than high tones, but do not have impairment of hearing for the spoken voice as tested with the phonographic audiometer because they still have good hearing for at least part of the tones in the conversational range. This small group is shown in the upper strip of Fig. 5 by the narrow band that is obliquely hatched in two directions.

Thirty-eight children, or 2.8 per cent of the 1365 examined, have, either with one or with both ears, an impairment for the spoken voice of 9 per cent or more, as tested with the Western Electric Co. 4A, or phonographic, audiometer under our conditions of use. They are represented in the upper strip of Fig. 5 by the zone at the right-hand end (oblique hatching in two directions and dots in the spaces of the hatching). The impression is widespread, from the earlier surveys with the phonographic audiometer, that about 10 per cent of school children have impaired hearing for the spoken voice. The incidence of 2.8 per cent in our group is, however, in good agreement with that of 3.29 per cent reported today by Dr. Newhart for Minnesota school children carefully tested with the phonographic audiometer, also with the incidence of from 2 to 4 per cent in different communities in Pennsylvania, reported verbally this month by Dr. T. Ern-

est Newland, Chief of the Special Education Department of Public Instruction, at the National Research Council Conference on Problems of Deafness.

Until many children with impaired hearing for high tones but good hearing for the voice have been re-examined periodically for several years, we cannot state what proportion of those with high tone losses do have an early stage of a serious progressive deafness, and what proportion have only lesions already stationary or self-limited. Certainly, however, the facts presented in Figs. 1 to 5 warrant the conclusion that a method better than testing with the phonographic audiometer should be used to discover those children in need of otologic care. Early recognition and treatment to prevent progression to a handicapping degree of impaired hearing should be our aim. Success in such a program, as in other fields of medical endeavor, will not be spectacular, except in statistical form, but in our present state of knowledge, prevention of deafness offers much more hope of success than does the cure of deafness after it has developed.

The factors of sex, age and the season of the year at which the examinations are made influence the incidence of impaired hearing for high tones in the children examined in this study. For adults, the importance of the age factor has long been recognized. Since the advent of the audiometer the studies of Bunch,¹ of Bunch and Raiford,² of Ciocco³ and of others have demonstrated conclusively that both age and sex are factors of importance in adults; and Ciocco's⁴ study of Washington school children with a 2A audiometer showed evidence of both factors in children. The effect of season has not previously been stressed.

The sex difference in incidence of impaired hearing for high tones is very marked in our material, as may be seen by mere inspection of the lower two strips of Fig. 5. Only 47.3 per cent of the boys have good hearing bilaterally for all tones, as compared to 70 per cent of the girls. On the whole, also, the high tone losses in the boys are more severe than in the girls.

Fig. 6 shows, in the same code of symbols used in Fig. 5, the incidence of impaired hearing with the material divided into two age groups of girls and of boys, respectively. The

groups labeled 8 to 10 years include the few children who are slightly younger than 8 years, and the groups labeled 11 to 13 years include the small number who are 14 years old. The four groups are of fairly equal size; from above downward, in order of the chart, the per cent in each group is, respectively, 27.7, 23.1, 24.1 and 25.1. For both sexes the increase in incidence of impaired hearing for high tones in the older group is definite. Failure to take the factors of sex and age into account can easily lead to erroneous conclusions in studies on the hearing of children as well as of adults.

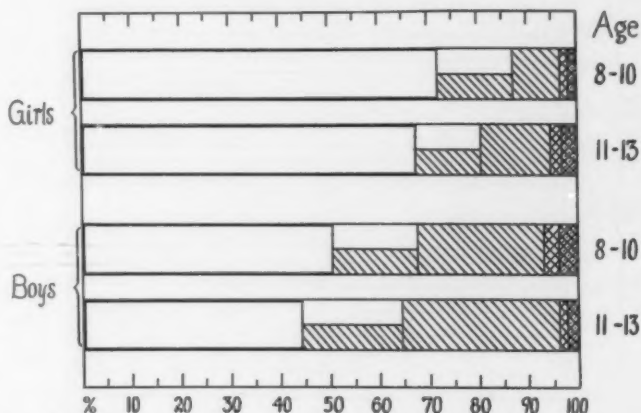


Fig. 6. Shows the increased incidence of impaired hearing for high tones in the older children of both sexes. Same symbols as in Fig. 5.

A seasonal effect on the incidence of impaired hearing for high tones is also apparent in our material, the incidence being greater in the children examined in the winter than in the autumn. This is easily seen by inspection of the several comparable groupings of the material in Fig. 7. "Autumn," for this study, includes examinations made in October, November and December up to the beginning of the Christmas holidays, and "Winter" those made in January, February, March and the first week of April. This somewhat artificial division into seasons agrees well with the actual weather in Baltimore this year. The number of children examined for the first time in these two seasons was, respectively, 721 and 644.

Somewhat more than half of the children examined in each season had previously had an operation for the removal of tonsils and adenoids (T. and A.). Of the entire material, 55.3 per cent had had a T. and A. before we first examined them. In view of the sex difference in hearing, it is of interest that more boys than girls had had a T. and A.; the percentages are, respectively, 59.2 and 51.5. Fig. 7 shows that an increased incidence of impaired hearing for high tones occurs in the winter, both in the groups of those who have not had tonsils and adenoids removed and in those who have

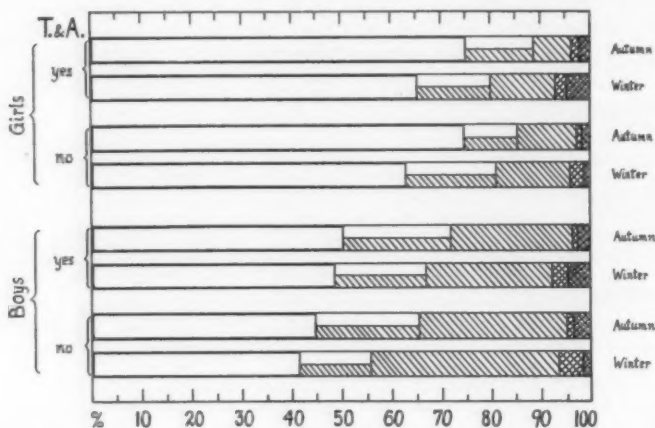


Fig. 7. The incidence of impaired hearing, with the children grouped as to sex, season of the year examined, and whether or not they had had a previous tonsillectomy and adenectomy (T. & A.). Symbols same as used in preceding two figures.

had a T. and A. Inspection of Fig. 7 also shows that more of the boys who had a T. and A. have good hearing than occurs in their "control" group (the boys who have not had an operation); there is no significant difference in the corresponding groups of girls.

At both seasons of the year, autumn and winter, the examining physicians described about one-third of the adenoids as small or moderate in size, slightly over half (55 per cent) as large, and about one-ninth as huge. In respect to size of the adenoids, no sex or age difference has been detected; however, as shown in Fig. 8, the incidence of normal tubal ori-

fices is about 8 per cent greater in the girls than in the boys of our material. Fig. 8 also shows that the percentage of boys and of girls, respectively, with open tubal orifices did not change materially with season, but for both sexes the percentage with complete overgrowth of the nasopharyngeal orifice of the Eustachian tube is greater in winter than in autumn.

The analysis shown in Fig. 9 was made to discover which type or types of impaired hearing for high tones increases

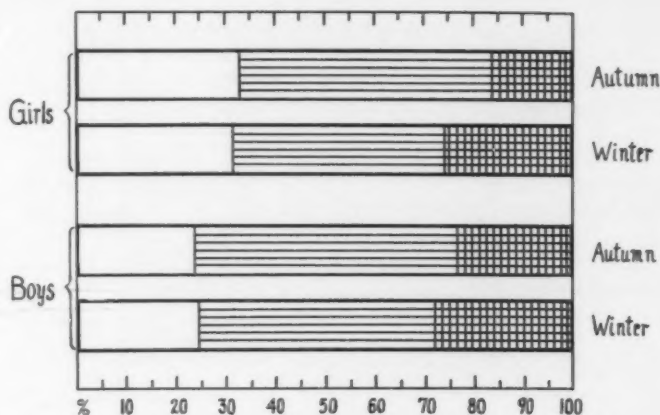


Fig. 8. The incidence of overgrowth of the nasopharyngeal orifice of the Eustachian tube, with the children grouped as to sex and the season of the year when first examined. The unshaded area of each strip represents the open, normal appearing tubal orifices; the horizontally ruled area, those with some degree of partial overgrowth with lymphoid tissue; the doubly ruled area, those that are so completely overgrown they cannot be seen on examination with a nasopharyngoscope.

in winter as compared to autumn; therefore, a different code of recording hearing impairments is used than in the preceding figures. The analysis is by ears instead of by individuals; the horizontally ruled area represents the "abrupt" type of loss, involving either the highest or the two highest frequencies tested (see Fig. 2); the area horizontally and obliquely ruled indicates the "abrupt" type losses that involve more than the two highest frequencies (see Figs. 2 and 3); the "gradual" high tone losses (see Fig. 4) are represented by the area with oblique hatching in two directions and dots in the spaces of the hatching; the unshaded areas to the left end of each strip represent ears with good hearing for all

tones; and the small, unshaded bands between the shaded areas represent ears with impaired hearing for more than high tones only. All degrees of overgrowth of the orifice of the Eustachian tube are grouped together in this chart. For each pair of groups made, the increase in impaired hearing in winter as compared to autumn is mostly due to the larger percentage with a "gradual" type of high tone loss. Fig. 9 also shows strikingly that overgrowth of the tubal orifice has an unfavorable influence on hearing.

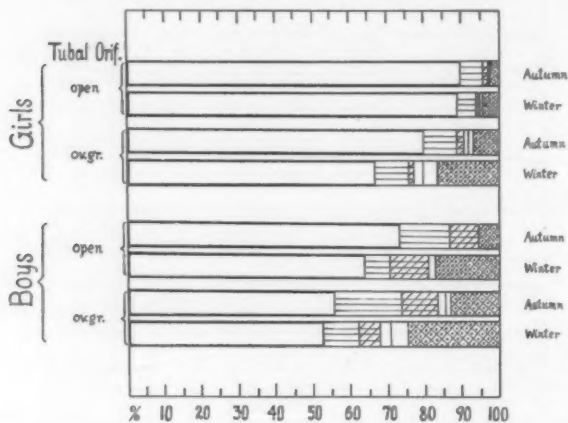


Fig. 9. An analysis of the seasonal increase in incidence of impaired hearing for high tones. See text for explanation of symbols used.

The condition of the teeth, in general terms, has been recorded for each child examined. The distribution is: teeth in excellent or good condition, 47.1 per cent; in fair condition, one or two with caries, etc., 31.7 per cent; in poor or bad condition, 21.2 per cent. It is reasonable to expect that the incidence of impaired hearing would be least in the children with good teeth and greatest in those with badly carious teeth. All of the analyses made, however, have failed to demonstrate any relationship at all between hearing impairments and condition of teeth in these children.

Likewise, we have sought, and again without finding significant differences, for relationships between hearing acuity and each of the following facts: the height, the weight, the

height-weight index, the circumference of the wrist at the level of the styloid processes, the circumference of the base of the neck, the wrist-neck index, the wrist-height index, the shape of the head and the shape of the face. The latter two items were not measured but were recorded only as impressions from observation. For each of the items that were recorded in arithmetical figures, all groupings in the analyses were by sex and age in years, and the incidences of impaired hearing in the extreme one-fourths of the group and in the median half were compared. In no instance did they differ by significant amounts. For example, the thin, underweight children have, as a group, no more impaired hearing than do those whose general nutritional condition is average nor than is found in the group of large, overweight children.

The appearance of the tympanic membrane, as seen on otoscopic examination, is not as closely related to hearing acuity as might be expected. The incidence of bilateral good hearing for all tones is, indeed, greatest in the children with bilaterally normal tympanic membranes, and the incidence of impaired hearing for high tones is greatest in the group with marked or extreme retraction of the tympanic membrane; however, nearly one-fifth of the children with both tympanic membranes entirely normal in appearance have some form of impaired hearing, and 44.5 per cent of those with a marked degree of retraction of one or both tympanic membranes have good hearing for all frequencies with both ears. The inconsistencies between the appearance of the outer surface of the tympanic membrane and the "expected" hearing are so numerous that advice with respect to individual children must always be based on a consideration of the entire examination, with special regard to the nasopharyngoscopic and otoscopic observations and the hearing tests.

In spite of an overgrowth of the tubal orifice with lymphoid tissue and a marked retraction of the tympanic membrane, the hearing may be excellent. We have found many such cases among the children examined this year. The hearing of such a child is, however, menaced by the conditions present, and the otologist should re-examine these patients periodically, twice a year or oftener until after puberty, to detect the possible beginning of impaired hearing. Already, in our control group of children (see page 733 for the basis of selection

of this group), a considerable number have developed an impairment of hearing for high tones during the three to four months between the two examinations thus far made, or have had the slight existing impairment definitely progress. The incidence of those in the control group whose hearing for high tones as a whole (the frequencies of 4,096 to 16,384, inclusive) became worse during the interval between examinations is shown in Fig. 10 by the oblique hatching in one direction. In this figure the control group is divided into four parts, according to the month in which the

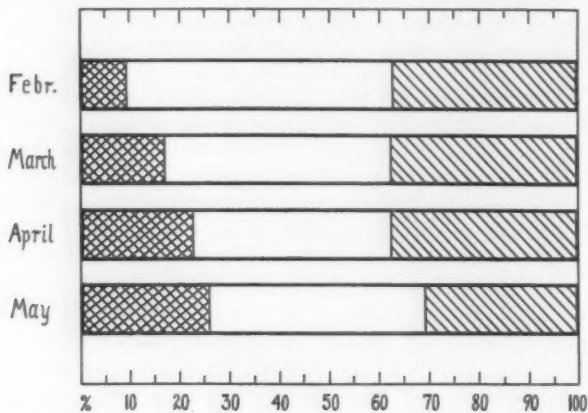


Fig. 10. The incidence of changes in hearing acuity for high tones in the control group of children. Grouping and symbols are explained in the text.

second examination was made. This arrangement brings out the marked seasonal effect on the incidence of spontaneous improvement in hearing acuity for high tones, which is represented by the areas obliquely hatched in two directions. The unshaded zone in each strip represents those whose hearing for high tones did not change. The children of the control group will be re-examined twice next year, and we hope to be able to follow most of them for many years.

In Fig. 11 are summarized, with the same code of symbols used in Fig. 10, the changes in hearing for the high tone region in the children who have been treated with radon. For ease of comparison, the averages for the control group are

given in the upper strip. The upper of the two strips labeled "Radon Therapy" shows the incidence of changes in those children who were re-examined from four to 12 weeks after having had but one treatment, and the lower strip shows the incidence of changes in those re-examined from 13 to 26 weeks after the first treatment. In the latter group the total number of treatments varies from one to four. Whether or not the incidence of improved hearing for high tones continues to increase with the lapse of more time is one of the things we can learn only from the re-examinations during the next school year.

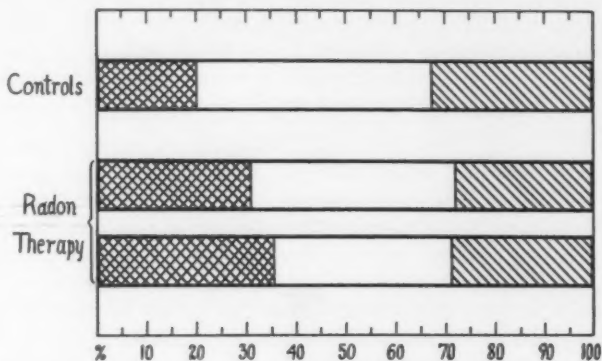


Fig. 11. The incidence of changes in hearing for high tones in the children treated with radon. See text for explanation.

Many of the children who have been treated undoubtedly have an impairment of hearing due to other causes, but occlusion of the nasopharyngeal orifice of the Eustachian tube certainly adds to the danger of further impairment, and such children have been given the benefit of the doubt as to the primary cause and have been treated. The re-examinations next year will give the information essential for a better estimate than can yet be made of the proportion of children whose impaired hearing is primarily caused by lymphoid hyperplasia.

As reported earlier in this paper, there can be no question that radon therapy is effective in reducing the size of the adenoid tissue of many children even during the worst sea-

son of the year for upper respiratory infections; but until these children have been followed for several years, we cannot say whether or not radon therapy is more effective than surgery in preventing the recurrent growth of adenoids.

Bad effects of the treatment with radon have not been observed in even a single instance.

Instead of summarizing this report of a study still in progress, we wish in conclusion to emphasize the two most important facts established. Over 40 per cent of the 1,365 school children examined do not hear all tones within the range of intensity commonly regarded as normal; and three-fourths of the entire group, all of whom are attending regular school classes, have nasopharyngeal conditions that are a potential menace to hearing.

Irrespective of whether or not radon therapy, surgery or some other method of treatment is best, these two facts are in themselves a challenge to the medical profession. The prevention of impaired hearing in children is clearly a problem of such magnitude that the co-operation of otologists, public health agencies, school authorities and family physicians will be needed for its successful practical solution.

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THE CLARIFICATION OF CERTAIN PHASES OF THE PHYSIOLOGY OF HEARING.*

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There is no real rhyme or reason in the selection of topics for this report — merely that they all are aspects of the physiology of hearing, concerning which some relatively recent items of information are available. The conclusions for the most part are not new, but it may afford us some degree of comfort to find support for ideas that we have already tentatively accepted, or clarification where there have been conflicting claims and theories.

To lend a semblance of sequence to my remarks, I shall follow the course of a sound wave, and after an uneventful journey through the external auditory meatus impinge upon the middle ear and activate the intra-aural muscles. We have learned from animal studies that these muscles contract reflexly in response to loud sounds, and that the transmission of sound through the ear is reduced by their contraction. The reduction is particularly effective for low tones. Contraction does not occur unless the tone is at least 40 db. above threshold, perhaps even 50 or 60. We may safely abandon the old suggestion that the intra-aural muscles served in some way to increase the sensitivity of the ear or tune it to pick up faint sounds. They are rather a protection against overstimulation, like the iris of the eye.

A case of paralysis of the intra-aural muscles as part of a transient right facial paralysis following a head cold, reported by Perlman (1938), confirms the theory of protective function and indicates the practical threshold of their activity in man. The patient complained that loud sounds, such as those from passing street cars or produced by dropping coal into an empty coal pail, were uncomfortable and annoying in his right ear. The threshold of hearing determined by audiometer was nearly identical for the two ears, and was actually a little lower on the affected side. Both ears showed marked

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but approximately equal hearing impairment for tones above 1,024 ∞ . When the subject was asked to compare the loudness of tones of frequencies 128 ∞ to 2,048 ∞ delivered alternately to the right and left ears, he appreciated no difference up to 60 dcb. At 70 dcb. the sounds were definitely louder in the right ear. A tone of 512 ∞ at 85 dcb. in the right ear was appreciated by the patient as equally as loud as the same tone in the left ear at 95 dcb. Unfortunately, his impairment of hearing for high tones made it impossible to determine whether the effect on transmission of paralysis of the intra-aural muscles extended above 2,048 ∞ . It will be recalled that in the experiments by Wiggers (1937) on guinea pigs, the impairment of transmission was confined to frequencies below 1,000 ∞ . The practical threshold for activation of the intra-aural muscles appears to be between 60 and 70 dcb. in this case, which is in good agreement with the studies of Lüscher (1929) and of Lindsay, Kobrak and Perlman (1936) on patients whose eardrums were missing or perforated.

Next, we approach the inner ear the hard way, by bone conduction. The mechanism of bone conduction was a topic of doubt, not to say dispute, for many years, even long after its diagnostic possibilities were well recognized, but v. Békésy (1939a and b) and, particularly, Ernst Bárány (1938) have placed our understanding of the mechanics on a new level of certainty. In the symposium on this subject held by this Society in 1936, Guild showed that the explanation of a series of anomalous cases of impaired bone conduction with normal air conduction lay in the presence of fractures of the bony trabeculae of the subaditus region. Evidently there is some preferential pathway through these trabeculae from mastoid to inner ear. But this observation does not tell us how the bone-transmitted sound wave sets the basilar membrane in vibration. It suggests rather, as Bárány also concludes, that, although the mastoid process may be the best region to which to apply the bone conduction receiver of an electrical hearing aid, it may be a poor point to select for diagnostic tests.

It now appears that bone conduction acts upon the inner ear by at least two mechanisms: 1. the inertia of the ossicular chain; and 2. the compression of the bony labyrinth. The second mechanism, championed by Herzog and later by v. Békésy, is dominant if the ossicular chain is absent, or

ankylosed or severely restrained in any way. It is thus of utmost practical importance to sufferers from transmission deafness who employ the bone conduction type of hearing aid, and also in our diagnostic tests. The sound wave is a wave of compression traveling through the bony structure of the skull, and as it passes through the temporal bone it squeezes fluid from the semicircular canals, vestibule and scala vestibuli toward the round window, which is the most flexible and yielding portion of the labyrinthine wall, particularly if the stapes is ankylosed. But if the ossicular chain is freely movable, the inertia of the ossicles themselves is sufficient to set up movements in the perilymph as the skull moves to and fro or rotates from the impacts of the bone

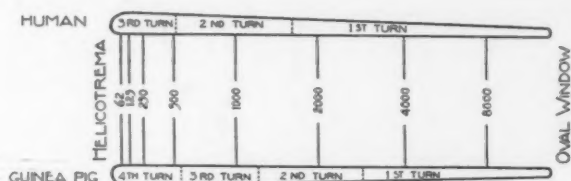


Fig. 1. From Stevens, Davis and Lurie, 1935.

conduction receiver. E. Bárány (1938) has given an excellent account of this mechanism in his recent monograph, and some of his remarks on the significance of bone conduction in the normal ear are worth repeating. He points out that if the ear is too sensitive to bone conduction it is a disadvantage, for then the sounds of our own voices, of chewing, of breathing, of the movements of blood, etc., arising within the head will form a loud background of noise that will mask external sounds and reduce our ability to detect and distinguish them. Nature has apparently taken pains to reduce the sensitivity of the ear to bone conduction by attaining a very accurate balancing of the ossicular chain. Here, Bárány suggests, it a benefit we derive from the complicated and apparently meaningless shape of the ossicular chain. It is so accurately balanced that its centre of gravity is not more than a third of a millimetre from its axis of rotation. Unbalancing the chain by attaching a weight of 30 or 40 mg. to the eardrum causes a great increase in the loudness of the sound of

chewing and a distinct lateralization of the tone of a tuning fork on the head.

Now, arriving at last at the inner ear, we meet our old friend, the theory of hearing. What is the physiological basis of pitch discrimination? Since the symposium of this Society on that subject in 1935, there have been a number of additional contributions to the subject, nearly all favoring the place theory. I feel that, with possible reservations as to very low tones — so low that the sense of hearing merges

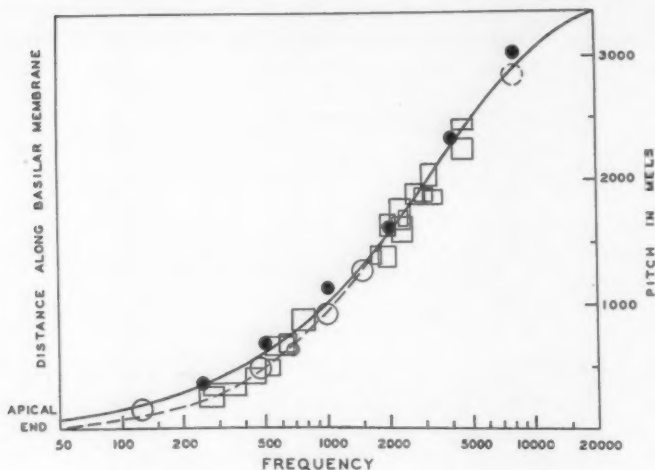


Fig. 2. From Stevens and Volkmann, *in press*.

over into the sense of vibration — we can confidently say that the sensation of pitch is determined by the position of the vibratory pattern on the basilar membrane and not by the frequency of nerve impulses in the auditory nerve.

You will recall that studies of the aural microphonics (the electrical response of the cochlea) in the guinea pig demonstrated directly a tuning of the cochlea. Relatively greater potentials in response to high tones were obtained from the round window and to low tones from the apex. More precise comparisons of voltages obtained at various intermediate positions enabled Culler (1935) to plot the optimal positions

for various frequencies. Kemp and Johnson (1939) have just repeated and confirmed Culler's observations. Stevens, Davis and Lurie (1935), by a method of localized lesions and impairment of electrical output, derived simultaneously with Culler an almost identical "map" of the cochlea. The location in the basal turn of the lesions in human ears responsible for abrupt high tone deafness had already been determined by Crowe, Guild and Polvogt (1934).

An entirely different approach, through psychophysical measurements, has led to maps almost exactly the same as those derived from the electrical studies. One method is based on measurements of the change in frequency necessary to

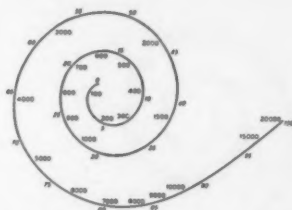


Fig. 3. Fletcher's map of position in the cochlea for maximum response to pure tones. From Fletcher, 1940.

produce a just-noticeable change in pitch. The assumption is made that a just-noticeable change in pitch represents a constant displacement of the region of activity along the basilar membrane. (Actually the shift necessary to produce a noticeable difference corresponds approximately to the distance occupied by two internal hair cells.) By integrating the steps of just-noticeable difference, Stevens calculated the positions that must be ascribed to the various frequencies.

Fletcher (1940) has carried out two other sets of calculations, the first based upon the width of the band of frequencies that a noise must contain in order to mask a pure tone, and the second based upon the ratio of the intensity of the necessary noise to the intensity of the masked tones. Time does not permit description of the details of the measurements or of the calculations, but the curves obtained are practically identical with one another and with the one derived from data on just-noticeable differences of pitch.

Still another method has been used by Stevens and Volkmann (in press). They have constructed a pitch scale by asking an observer to set the pitch of a test tone half-way between the pitches of two tones that are presented to him. Another method is to ask the observer to set his tone at half the pitch of a single tone presented to him. The results enabled Stevens and Volkmann to draw a curve that gives directly the relation between subjective pitch and the frequency of a tone. This curve is projected on the basilar membrane by making the assumption that equal intervals on the pitch scale represent equal distances on the basilar membrane. The result is the solid line shown in Fig. 2. The solid dots in the figure represent Culler's data as recalculated by

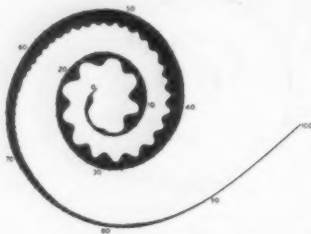


Fig. 4. Auditory pattern of steamboat whistle. From Fletcher, 1940.

Steinberg. The open rectangles and circles represent the data obtained by Stevens, Davis and Lurie (1935). Fletcher's curve (1940) and Stevens' earlier curve (1935), based on the just-noticeable differences of pitch, are scarcely to be distinguished from one another and they coincide with the solid line above the frequency of 1,000 ∞ . Below 1,000 ∞ they run directly through the open rectangles, as shown by the broken line in Fig. 2.

Thus we find it possible to construct a map of the basilar membrane consistent with these six sets of data:

1. Position of maximum electrical activity.
2. Impairment of electrical activity by localized lesions.
3. Pathological changes associated with high tone deafness.
4. Integration of just-noticeable differences of pitch.

5. Contribution of different parts of the basilar membrane to the total loudness of a sound.

6. The relation of pitch, subjectively perceived, to the frequency of a tone.

With this mass of independent supporting data we can now accept with full confidence the "maps" of the cochlea shown in Figs. 1 and 3. Frequency 2,200 lies at the midpoint of the basilar membrane. The low octaves are relatively more and more compressed as we approach the apex.

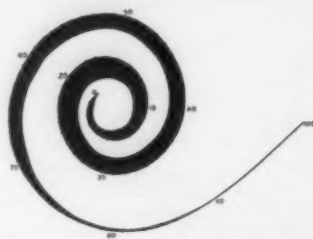


Fig. 5. Auditory pattern of street noise. From Fletcher, 1940.

With this map in hand, Fletcher (1940) has calculated the "auditory patterns" produced by various types of sound. The subjective loudness contributed by each "patch" or unit of length of the membrane is represented by the thickness of the black pattern drawn along the spiral of the cochlea. These patterns are instructive visualizations of how sounds are perceived by the ear. Fig. 4 represents the auditory pattern of a steamboat whistle, with a fundamental frequency of 100∞ and many strong harmonics. Street noise has a wide distribution of loudness along the basilar membrane, but it has no tonal quality and no distinctive peaks. The next auditory patterns are those of four notes of a bugle playing "taps." The characteristic distribution of loudness among the various harmonics gives the sound the quality of a bugle, and the position of the whole complex pattern gives us the pitch. The patterns of pure tones are simple humps unless the tone is loud enough to cause the ear to introduce aural (so-called "subjective") harmonics.

And now a final item that reaches the auditory nerve itself. If we pass an alternating electric current through the head,

we can, if the frequency is not too high and the intensity is carefully adjusted, hear a musical tone or a noise. Unfortunately for possibilities of using this electrophonic effect as a hearing aid, the zone between the threshold of hearing and the threshold of tickle, of pain and of vertigo is very narrow. Jones, Stevens and Lurie (in press) have continued their analysis of this interesting phenomenon and find that it arises in one or more of three different ways, depending upon various circumstances. Ordinarily, if the eardrum is intact, the tympanic membrane is periodically attracted by electrostatic force to the promontory opposite to it. Unless a direct-current polarizing voltage is also applied, the subject hears a

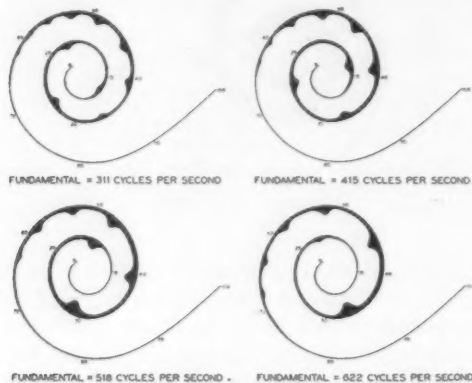


Fig. 6. Auditory pattern for four notes of bugle playing "taps." From Fletcher, 1940.

tone an octave above the frequency of the alternating current, since the eardrum is attracted to the promontory twice in each cycle, at both the positive and the negative peak. If, however, the eardrum is missing and the voltage is applied to the round window, the subject usually hears a tone corresponding to the actual frequency of the current. We are not quite so sure as to the mechanism in this situation. The most plausible guess is that whatever mechanism in the ear normally generates electricity and produces the aural microphonics when sound agitates the basilar membrane is being operated "in reverse," so to speak, and causes the basilar membrane to vibrate in response to the alternating current

applied to the ear. We can sum up this explanation by saying that this particular *electrophonic* effect is the inverse of the familiar *aural microphonic* effect. And, finally, some subjects without eardrums hear only a noise, or sometimes both a noise and a tone. The noise is undoubtedly due to direct electrical stimulation of the auditory nerve. The vertigo that is felt when too strong a current is applied is obviously due to stimulation of the vestibular portion of the VIIIth nerve. The current stimulating the auditory nerve produces a sensation of noise, not a tone, because the fibres excited are selected at random by the current. Only when a group of fibres innervating a particular part of the basilar membrane are excited do we hear a tone. The analyzing mechanism of the inner ear remains an essential part of the mechanism of hearing. Incidentally, Stevens finds the frequency theory of hearing untenable even for low tones, as some of his subjects hear only noises, not tones, all the way down to one cycle per second.

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CLINICAL OBJECTIVES IN THE CHEMOTHERAPY OF HEMOLYTIC STREPTOCOCCUS INFECTIONS.*†

DR. CHAMP LYONS and DR. ROBERT NORTON GANZ, Boston.

Four years' experience with sulfanilamide in hemolytic streptococcus infections has failed to establish the criteria of therapeutic success. The recognition of these objectives requires careful studies upon the clinical nature of the infection, the virulence of the bacteria and the antibacterial immunity of the patient. The successful treatment of an individual patient and the evaluation of the newer drugs demand the definition of these objectives in chemotherapy. Experience is still too limited for a final statement of these objectives but it is hoped that the studies reported here may lay the basis for more precise analyses of chemotherapeutic success.

REVIEW OF PERTINENT LITERATURE.

The protective antibody in hemolytic streptococcus infections has been shown to be an antibacterial antibody, and a phagocytic method has been devised for the rapid estimation of the presence of such antibody in human serum.^{1, 2} Inasmuch as there is no commercial supply of immune serum, it was necessary to develop the immunotransfusion technique³ in order to passively immunize infected patients. This procedure was shown to be of great value before sulfanilamide was available in this country.³

In 1938, it was demonstrated that sulfanilamide and antibacterial antibody were synergistic in experiments in human blood and in the clinical management of bacteremic patients who were refractory to chemotherapy alone.⁴ The clinical need for both immune serum and sulfanilamide in the management of bacteremic infections has been confirmed.^{5, 6} Experimentally, the synergism of the two substances has been observed in mouse infections by Behrens⁷ and Loewenthal,⁸ but not by Colebrook.⁹ Colebrook,⁹ however, has confirmed

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the previous observation⁴ of such a synergism in experiments in human blood. The available evidence suggests that the combination of immune serum and sulfanilamide is more effective than either substance alone in the treatment of infected humans but this awaits statistical proof.

TABLE I.

Case No.	Antibody*		Time of Response	Recur- rence	Drug	Blood Level Mg. %
	Start	Finish				
1	0	0	1 day	0	Sulfanilamide	11
2	0	0	1 day	0	Sulfanilamide	7
3	0	0	1 day	0	Sulfanilamide	10.5
4	0	0	2 days	0	Sulfathiazole	2.5
5	0	0	3 days	+	Sulfanilamide	—
6	0	0	4 days	0	Sulfanilamide	8
7	0	0	5 days	+	Sulfapyridine	4
8	0	0	6 days	0	Sulfanilamide	16.2
9	0	0	7 days	+	Sulfanilamide	14
10	0	0	10 days	+	Sulfanilamide	11.5
11	0	0	10 days	0	Sulfanilamide	12
12	0	0	10 days	+	Sulfanilamide	12
13	0	0	40 days	0	Sulfanilamide	12
14	0	+	10 days	+	Sulfanilamide	13
15	0	++++	1 day	0	Sulfanilamide	13.5
16	+	—	1 day	0	Sulfapyridine	7
17	+	+	1 day	0	Sulfapyridine	8
18	+	—	1 day	0	Sulfapyridine	7
19	++	—	1 day	0	Sulfapyridine	8
20	++	—	1 day	0	Sulfanilamide	15
21	++	+++	2 days	0	Sulfanilamide	7
22	++	—	2 days	0	Sulfapyridine	6

Studies on Patients in Whom Chemotherapy Was the Sole Therapeutic Procedure.

* 0 = Less than 50 cocci phagocyted by 25 polymorphonuclear leukocytes.

+ = 50-100 cocci phagocyted by 25 polymorphonuclear leukocytes.

++ = 100-150 cocci phagocyted by 25 polymorphonuclear leukocytes.

+++ = 150-200 cocci phagocyted by 25 polymorphonuclear leukocytes.

++++ = More than 200 cocci phagocyted by 25 polymorphonuclear leukocytes.

Keefer¹⁰ has maintained that a chemotherapeutic effect coincides with the development of host resistance and attempts to measure such an increase in resistance by a bactericidal test. This test as performed by Keefer measures nonspecific factors¹¹ and bacterial virulence,^{1,2} in addition to type-specific antibacterial immunity, and is thereby disqualified as a test for specific immune bodies. Keefer's results in humans are different from the results in animals because mice^{12,13} and guinea pigs¹⁴ fail to develop a protective immunity as a consequence of survival from a sulfanilamide-treated hemolytic streptococcus infection.

CORRELATED IMMUNOLOGIC AND CLINICAL STUDIES.

1. The Formation of Antibacterial Antibody in Patients:

We have realized for some time that patients may recover from a hemolytic streptococcus infection without developing an antibacterial immunity. In such instances the infection is exteriorized or localized within the body by the process of inflammatory fixation, and recovery occurs when an abscess is drained. Chemotherapy has led to the arrest of infections without suppuration but there are still many patients who fail to develop antibody in consequence of their infection. In an effort to evaluate the importance of antibacterial antibody upon the course of a sulfanilamide-treated infection, antibody studies were done on patients at the start and conclusion of chemotherapy. The results are summarized in Table I. The cases are comparable only in the sense that there was no focus of undrained pus present. Although no statistical significance is attached to the series, it would seem reasonably clear that delayed response and recurrences of infection occur predominantly in the group of patients who have no antibacterial antibody at the time treatment is started and who fail to develop antibody subsequently.

2. The Clinical Response to Sulfanilamide in Patients With and Without Antibody:

The administration of sulfanilamide for a nonsuppurative infection in patients with antibody usually leads to definite improvement in 12 hours and the apparent arrest of the infection within 48 hours. This response has been selected as the constant objective of all therapy in hemolytic streptococcus infections. Chart 1 illustrates such a response in the following patient:

M. G. H., No. 215852, age 11 years, developed a septic sore throat during convalescence from a sequestrectomy of the tibia. The sore throat subsided with symptomatic treatment, but in some way the streptococcus from his throat became implanted in his operative wound, with resultant cellulitis and lymphangitis. An antibody determination showed 118-88 per cent (88 per cent of leukocytes contained intracellular cocci, and 25 leukocytes counted contained a total of 118 cocci). Chemotherapy in moderate dosage produced a normal temperature and an arrested infection within 48 hours, with a significant improvement in 12 hours.

Patients with no antibacterial antibody may fail to respond to chemotherapy and their clinical course is marked by persistent fever, local suppuration and persistent nonsuppurative inflammation of the lymph nodes. Long and Bliss¹⁵ have advocated prolonged chemotherapy in this group of cases but their suggestion does not provide for the management of the infection when it is necessary to stop chemotherapy because of the onset of toxic symptoms. An instance of this

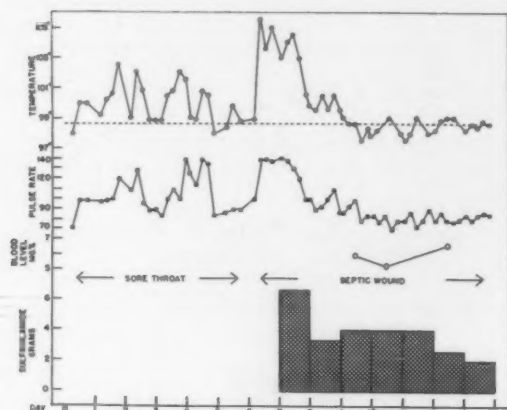


Chart 1. M. G. H., No. 215852. The chemotherapeutic response in a patient with antibacterial antibody.

problem is provided in Chart 2, with the following case history:

P. H., No. 222280, age 27 years, was admitted with cellulitis of the fascial planes of the right lower leg and lymphangitis. Chemotherapy and operative drainage of the leg were employed and the patient was gradually improving. On the seventh day of sulfanilamide therapy he developed a palpable tender liver and slight jaundice, which was considered a toxic hepatitis due to drug poisoning. Omission of chemotherapy was followed by exacerbation of the infection. The immunologic studies revealed an absence of antibacterial antibody and an immunotransfusion was given. This was extremely effective and it is significant that an infection which failed to respond to chemotherapy was controlled by immune serum.

If toxic symptoms occur with sulfanilamide it is frequently possible to change to sulfapyridine without a continuance of the toxic symptoms. It is our clinical experience that sulfapyridine is equally ineffective in the control of infections due only to the hemolytic streptococcus which have failed to respond to sulfanilamide. On this basis, the development of sulfanilamide toxemia in a patient with persistent infection has been considered an indication for a change to sulfapyridine with coincident immunotransfusion. Chart 3 illustrates

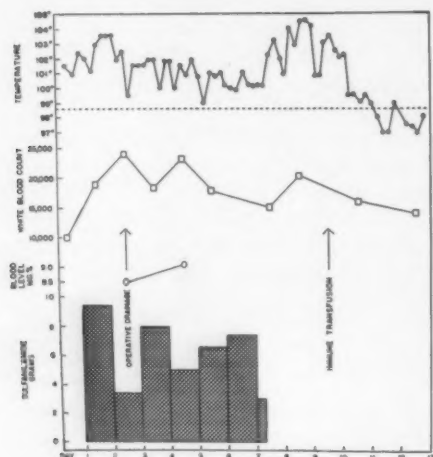


Chart 2. P. H., No. 222280. Infection in a patient with no antibacterial antibody and in whom toxic symptoms made it necessary to omit chemotherapy before the infection was controlled. Immunotransfusion controlled the infection after sulfanilamide was stopped.

this method of treatment and the patient's record is summarized below:

C. H., No. 217486, age 4½ years, received sulfanilamide for a hemolytic streptococcus infection of the tonsils and acute cervical lymphadenitis. A blood level of 8 mg. per cent was maintained until the drug was omitted on the eighth day of treatment because of the onset of drug fever and a cutaneous rash. The rash cleared, but the septic throat, enlarged cervical glands and spiking temperature persisted. Immunologic studies revealed an absence of antibacterial antibody and an

immune donor was selected. Chart 3 illustrates the recurrent infection after omission of sulfanilamide and the response to the use of immune serum and sulfapyridine together.

In addition to the cases reported in Table I, there were encountered 10 patients in whom acute otitis media had progressed to clinical mastoiditis during chemotherapy. None of these patients had any demonstrable antibacterial antibody in their serum at the time the mastoiditis was recognized. Of these 10 patients, one came to immediate operation

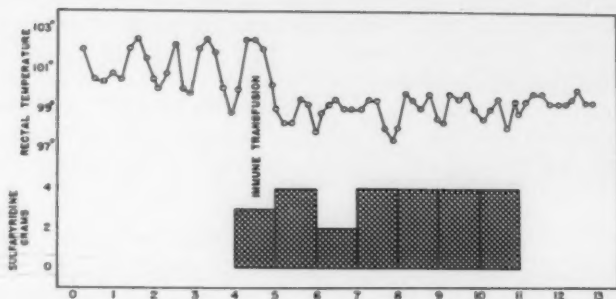


Chart 3. C. H., No. 217486. Recurrence of infection after omission of sulfanilamide for toxic symptoms. Control established for sulfapyridine and immunotransfusion. Temperatures are rectal.

because of periphlebitis of the lateral sinus, another received only immune serum and required mastoidectomy, and eight received both immune serum and further chemotherapy. Five of these eight cases subsided without operative drainage, and three required mastoidectomy. The cases which responded to the drug and serum treatment were those in which the X-ray showed diffuse cloudiness of the mastoid cells, whereas the failures were in the cases showing decalcification. The following summaries are illustrative:

C. H., No. 236238, age 8 years, suffered a spontaneous drainage of an acute otitis media. Drainage and fever of 103° F. persisted for nine days before she first consulted a physician. A culture of the aural discharge revealed beta hemolytic streptococci, and sulfanilamide was given in sufficient dosage to establish a blood level of 7.4 mg. per cent. On the tenth day of therapy it was necessary to stop sulfanilamide because of the development of rash and fever. The rash

cleared and the temperature returned to normal, but the aural discharge continued and mastoid tenderness became evident. An x-ray plate on the seventeenth day of aural discharge showed diffuse cloudiness of the pneumatic structures about the left auditory canal. Immunologic studies showed an absence of antibacterial antibody. Immune serum and sulfapyridine were started and within 48 hours the ear was dry for the first time and the mastoid tenderness had disappeared. The child has remained symptom free during the past seven months.

C. H., "D. S.," age 3 years and 7 months, was admitted with scarlet fever and a draining ear. She received sulfanilamide for 12 days but remained febrile and the aural discharge persisted. Immunologic studies revealed an absence of antibacterial antibody and an X-ray showed diffuse cloudiness of the mastoid. She received serum from an immune donor, and sulfathiazol. Within 48 hours the ear was dry and the temperature normal.

C. H., "C. R.," age 6 years and 7 months, had a myringotomy for acute otitis media. The aural discharge persisted during seven days of sulfanilamide therapy and five days of sulfapyridine therapy. There was no antibacterial antibody, and a mastoid X-ray showed bone destruction. Immune serum and chemotherapy were given together, but the mastoid tenderness and aural discharge persisted during the next 48 hours. Simple mastoidectomy disclosed pus and necrotic bone. The convalescence was entirely uneventful but this patient demonstrates the failure of immune serum and chemotherapy in the presence of undrained pus and necrotic tissue.

3. *Causes of Persistent Fever or Infection in Patients Receiving Sulfanilamide and Possessing Antibacterial Antibody:*

In the above discussion, emphasis has been placed upon antibacterial antibody as a determinative factor in the clinical response to chemotherapy. Such antibody is not the only factor involved by any means, for there are an equal number of cases that fail to show improvement when both antibody and sulfanilamide are present in high concentration. Segregation of this group of sulfanilamide "failures" by the appropriate immunologic and chemical tests for antibody and blood

sulfanilamide levels has permitted an interesting study. It has been found that the differential diagnosis of persistent fever in this group is concerned with:

1. *Scarlet Fever*: The erythrogenic toxemia of established scarlet fever may produce fever after the institution of chemotherapy even in the presence of antibacterial antibody. Our small experience with this disease prejudices us to use both sulfanilamide and antitoxin in any serious scarlatinal infection.

2. *Undrained Pus or Necrotic Tissue*: Undrained pus does not necessarily prevent a normal temperature in a sulfanilamide-treated patient, but such pus is frequently responsible for persistent fever, and proper treatment demands surgical drainage.

3. *Intravascular or Perivascular Sepsis*:

a. *Endocarditis*: Immunologic studies have been possible in four cases of hemolytic streptococcus endocarditis, and antibacterial antibody has always been present in large amounts. Chemotherapy has been used without effect in this group but there has been no opportunity to try the combination of sulfanilamide and heparin.

b. *Thrombophlebitis or Periphlebitis*: Antibody may or may not be present in this group of patients, but in either event chemotherapy may prove ineffective. This is most strikingly true in the intracranial or pericranial infections. Clinical experimentation in progress indicates that immune serum, sulfanilamide and heparin may be a more effective means of treatment in this group of cases.

4. *Drug Fever*: Among the toxic effects induced by chemotherapeutic agents, fever and leukocytosis are most apt to mimic an inflammatory spread. We regard the differential diagnosis between uncontrolled infection and drug fever without skin rash as the most difficult problem in chemotherapy. Not infrequently it is necessary to stop the drug therapy and await a clinical change. This may be done with greater assurance when antibody is known to be present.

4. *Routine Transfusions vs. Immunotransfusions*:

Frequently repeated small transfusions have much clinical recommendation for use in the treatment of streptococcus

infections, and the result is occasionally brilliant. Immuno-transfusion guarantees the brilliant result, but this is not the only reason we prefer to use an immune donor. It has been observed frequently that the serum of donors of compatible red blood cell groups may actually depress the phagocytic efficiency of the recipient's leukocytes. Table II records an experiment in which Group IV sera were added to Group IV bloods containing antibacterial antibody to different strains of streptococci. It should be noted that serum

TABLE II.

Serum Added	Strain "Cole"		Strain "Doody"
	Control	"E1" Blood	"Doody" Blood
None	0-0%	185-60%	128-56%
No. 1	24-16%	142-64%	121-60%
No. 2	4-4%	52-28%	44-24%
No. 3	0-0%	192-64%	32-16%
No. 4	6-4%	142-72%	227-60%
No. 5	31-16%	96-72%	58-24%
No. 6	38-16%	66-72%

The Antiphagocytic Property of Compatible Human Serum.
All Bloods and Sera Are from Group IV (Moss).

Note that serum No. 2 depresses phagocytosis in both "E1" and "Doody" bloods, whereas serum No. 3 depresses the phagocytosis only in "Doody" blood.

*128-56% = 128 cocci phagocytized by 25 polymorphonuclear leukocytes, and 56 per cent of the polys. were actively phagocytic.

See References 1, 2 and 3 for methods.

No. 1 was without effect in either blood, sera No. 2 and No. 5 depressed phagocytosis about equally in both bloods, serum No. 3 was depressant in one blood but innocuous in the other, and serum No. 4 stimulated phagocytosis in one blood but had no effect in the other. The mechanism of this depressant effect of homologous human serum is obviously complicated and not to be assigned to a substance which is toxic for all leukocytes. From a practical point of view, such observations have influenced us to use known immune donors whenever we wished to transfuse any seriously infected patient.

It has been shown¹⁶ that the serum of a patient receiving sulfanilamide may cause the spontaneous agglutination of red blood cells from a compatible blood if the blood has been chilled initially. Transfusion reactions with the blood of compatible donors have been encountered in the course of

drug therapy and it has seemed desirable to use serum instead of whole blood for immunotransfusion in patients with no anemia. The substitution of serum for whole blood does not affect the immunizing efficiency of the procedure and makes it possible to use donors of any blood type,¹⁷ providing precautions are taken to exclude the occasional serum which has an abnormally high agglutinin titre.

COMMENT AND SUMMARY.

We believe that the clinical objective in the chemotherapy of hemolytic streptococcus infections should be to secure dramatic improvement within 12 hours, and a normal temperature and an apparently arrested infection within 48 hours. Failure to achieve such a response demands investigation of the following possible causes:

1. Inadequate blood concentrations of the chemotherapeutic agent.
2. Deficiency of antibacterial antibody.
3. Coexistent erythrogenic toxemia of scarlet fever.
4. A focus of inflammatory fixation; *i.e.*, undrained pus or necrotic tissue.
5. Intravascular or perivascular sepsis, either thrombophlebitis or endocarditis.
6. Drug toxemia.

A deficiency of antibacterial antibody has been found to be a responsible factor in faulty therapeutic response and in recurrences of infection after chemotherapy is omitted. For this reason we propose to continue our studies upon antibacterial immunity as an integral part of drug therapy and to use immunotransfusion for the passive antibacterial immunization of infected patients.

Drug toxemias are hazardous to the patient and may mimic inflammatory spread. The second week of therapy presents these complications with increasing frequency, so that our efforts have been to terminate intensive chemotherapy within the first 10 days of treatment. This is more often possible when persistent symptoms of infection after 48 hours of chemotherapy are regarded as evidence of an inadequate

chemotherapeutic response. Early recognition of this inadequacy permits supplemental therapeutic procedures before drug toxemia becomes an important factor.

Further experience may modify the details of this plan but we believe it offers a sound basis for intelligent treatment and the evaluation of new drugs.

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**A NEW AMPLIFIER HAVING CHARACTERISTICS
SIMILAR TO THOSE OF THE HUMAN EAR,
AND ITS APPLICATION TO THE
PROBLEM OF DEAFNESS.***

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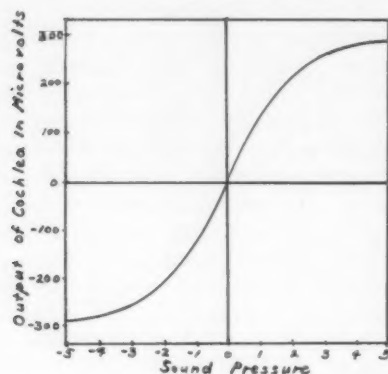
Present practice, when amplifying and reproducing sound signals, is to keep the overall instantaneous input-output characteristic of the sound amplifying and reproducing equipment as linear as possible. Great pains have been taken to keep the distortion in the amplifier and the electroacoustical devices as low as practicable. Because all sound equipment has a limit to the maximum sound it is possible to handle without excessive overload, and an inherent noise level below which the desired sound signal becomes masked, it has become common practice to monitor the gain of the amplifier, either manually or automatically, in such a manner that the sound signal is kept above the noise level and below the overload point of the equipment. Care is exercised to limit the rate of change in gain to avoid "plop" and other undesirable effects which are well known to those familiar with amplifying and monitoring equipment and which we will not discuss in this paper.

It has long been known that the normal human ear is capable of handling tremendous ranges of sound energies without difficulty, much greater ranges than are handled by ordinary sound equipment. It has more recently been shown that the instantaneous sound pressure versus sensation to the brain characteristic of the ear is not linear (see Fig. 1; see also "Hearing," by Stevens and Davis, p. 195, Fig. 82). This characteristic, when plotted on a logarithmic scale, becomes a straight line over an extended part of its length. My experiments indicate that the straight line part of this curve extends over quite an extended range. Over this straight part of the characteristic, the curve can be approximately expressed by the expression $P_e \propto V^n$, where P_e is the

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sound pressure picked up by the ear, V is the voltage or stimulus to the brain, and n is an arbitrary exponent introduced by the hearing mechanism of the ear and is generally greater than one. This exponent, n , in the human ear takes different values at different frequencies; i.e., different wave-front steepnesses (see Figs. 2, 3 and 5). In general, in the



from Stevens and Newman.

Fig 1

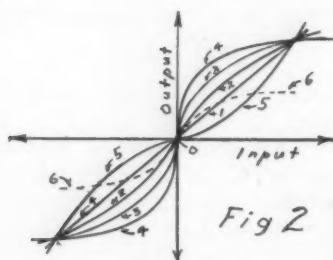
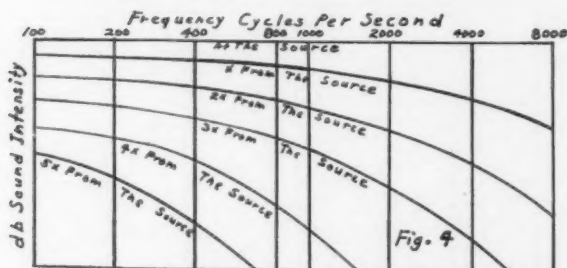
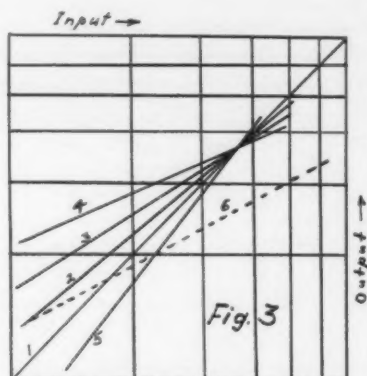


Fig 2

normal human ear, this exponent has its greatest value at about 3,000 cycles per second (see Fig. 5). This is Nature's method of compensating for the normal loss of the higher frequencies due to increasing absorption effects at increasing distances from the source. This characteristic of the ear keeps the timbre of the sound signals reaching the brain more nearly constant as the listener moves away from the source of the sound.

It is generally recognized that the human ear has some sort of compensatory mechanism comparable to that of the eye, which causes the ear to be more sensitive in a quiet room than in noisy surroundings. This accommodation of the ear takes place over a relatively long period of time compared to the rate of change of sound intensities. It may take a considerable length of time for the ear to reach its final state of

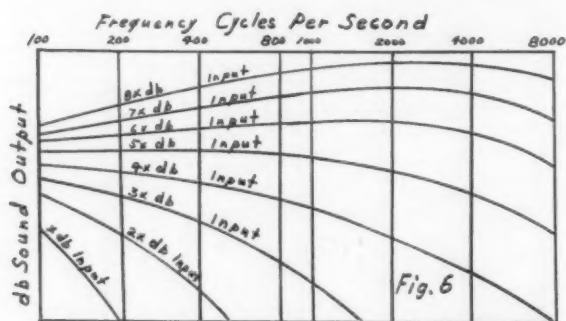
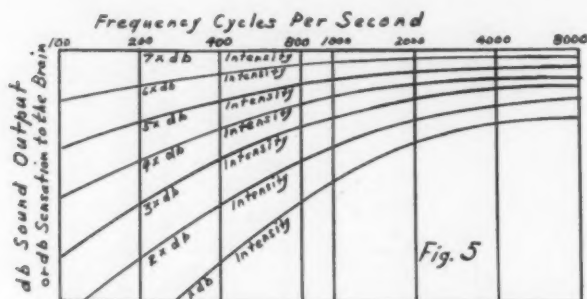


accommodation for any one sound intensity level. This accommodation takes the form of a change in the slopes of the straight line sound pressure brain sensation curves plotted on logarithmic paper, and can be roughly represented by changes in the values of the exponents, n . The characteristics remain approximately straight over roughly the same range of V stimulus to the brain for all values of n .

It is also generally known that the hearing nerves are not directly sensitive to certain low frequencies, but that these

frequencies are heard indirectly by means of the harmonics generated in the hearing mechanism.

From the above discussion it can be seen that the brain is accustomed to interpreting distorted waves or stimuli, and that it has trained itself to disregard or hear as natural this type of distortion. It should be noted here that the actual range of stimuli intensities received by the brain is consid-

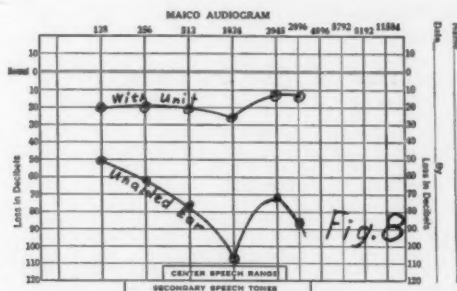
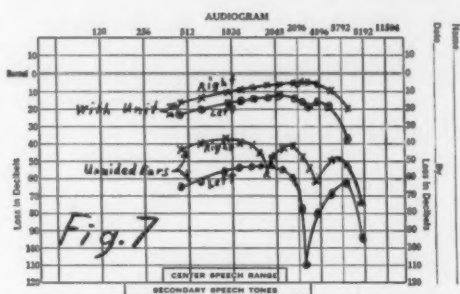


erably less than the range of sound pressures actually listened to. Also, that the brain can recognize a tone when only its harmonics, in the proper relationship, are heard.

It follows from the above that distortion similar to that introduced in the ear itself can be introduced in sound amplifiers and reproducing systems without causing a change in the apparent quality of the sound listened to. The combined characteristic of the amplifier and the ear results in a new

overall characteristic that has a new exponent which the brain thinks is introduced in its own ear, and if this overall exponent is objectionably high, the brain will automatically cause the exponent in its own ear to be reduced, thereby restoring the overall exponent to a normal value.

From the standpoint of the effect on sound systems, it can be seen that a much wider range of sound sensations can be



included between the noise level of the recording media, the telephone line, the radio link, or a hearing aid, and the overload points of these same elements.

In certain types of deafness, the patient has lost in a large measure his ability to distort or accommodate his hearing to wide ranges of sound intensities. To such a person, loud sounds become more painful, and weak sounds less audible than they are to persons with normal hearing. Persons having this lack of accommodation are also more prone to have

"holes" at certain frequencies in their hearing characteristics. Figs. 7 and 8 show the audiograms of two persons having such holes in their hearing, and these figures also show how the holes tend to be filled in when the proper nonlinear characteristic is introduced into a properly fitted hearing aid. The proper fitting of a hearing aid for such cases consists of adjusting the general frequency characteristic of the unit to complement the general trend of the hearing loss and, most important, adjusting the characteristic of the amplifier to have its maximum exponent at the frequency or at a harmonic of the frequency at which the patient's loss is most acute. In this way the proper harmonics of the missing frequencies can be emphasized so that the patient gains the illusion of hearing the lost tones.

Patients having such holes in their hearing characteristics have a tendency to be over-critical of all conventional hearing aids and claim that all hearing aids are noisy, unintelligible, and make them nervous and irritable. These same patients report that hearing aids incorporating the above described "distortion" are not only more intelligible, but seem to induce a lesser degree of nervous strain than conventional units.

As an illustration of these principles to those of us who are not deaf, I have introduced the above mentioned type of distortion into a small radio receiver. As we all know, it is impossible for these small radios to effectively reproduce low frequencies because of their lack of speaker baffle. Yet, such a radio having distortion properly introduced sounds less distorted and sounds as though it has good low frequency response. For purposes of comparison, I have brought along an unaltered receiver of the same type.

I realize that I have merely scratched the surface of this field of utilizing distortion to aid the hard-of-hearing. I sincerely hope that this paper may contribute one step towards minimizing their misfortune.

TREATMENT OF DEAFNESS.*

DR. LOUIS K. GUGGENHEIM, West Los Angeles.

During the past year progress has been made in the treatment of hearing impairment resulting from the lymphomesenchymal complex, Ménière's syndrome, otosclerosis and the neuropathies.

LYMPHOMESENCHYMAL COMPLEX.

Unresorbed tubotympanal mesenchyme plus lymphoid tissue in the nasopharynx is the commonest cause of deafness. Exuberant lymphoid growth and persisting mesenchyme are possibly the result of the same germinal layer peculiarity. The inadequate ventilation of the tympanum from nasopharyngeal lymphoid tissue seems also to play a rôle in the failure of mesenchyme to resorb. Adenoidectomy is incomplete in the majority of T and A's, judging from many cases which have come under our observation.

Where the neural mechanism is intact, the G vault operation results in a return of hearing to normal within three months, in the majority of children under 12 years of age. The operation, which has been unsatisfactory in older patients, consists of the removal of adenoid tissue in the usual way with La Force instruments. After controlling bleeding with adrenalin-soaked sponges, the soft palate is gently elevated with the Andy Love retractor, giving a perfect view of the entire nasopharynx. With forceps and curved scissors all lymphoid tissue protruding from the surface is meticulously removed. The tubal orifices are now in plain view. Into each is inserted the Gergoye metal olive, gentle pressure then being exerted for 20 seconds. No after-treatment is indicated. The procedure is done under ether anesthesia. It is presumed that the pressure of the olive plus the normal ventilation which follows the removal of lymphoid tissue results in the destruction of young connective tissue within the tube and in the eventual resorption of mesenchyme.

*From the Departments of Otolaryngology, University of Southern California and Washington University. Presented before the Research Study Club of Los Angeles, Jan. 26, 1940.

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MENIERE'S SYNDROME.

The impairment of hearing from so-called Ménière's disease may fluctuate with the attacks, returning to normal or near normal after each seizure or the hearing may be profoundly and permanently affected. The consensus, as to underlying pathology, is that the Ménière syndrome is due to a sudden and marked increase in endolymphatic pressure with resulting disturbance of the finely adjusted tonus impulses from the vestibular apparatus and irritation of the cochlear end-organ. Where pressure continues unabated, end-organ degeneration occurs. The symptoms are vertigo, disturbed equilibrium, nausea, tinnitus and impaired hearing. The condition is usually unilateral. As for the basic cause of the increased endolymphatic pressure, there is no certainty. One theory is that sodium retention and water imbalance are responsible.

The Furstenberg treatment, directed toward a release of retained sodium, is salt-free diet and ammonium chloride. The salt-free diet produces a return of sodium to the body fluids to supply the deficiency produced by the diet. The Cl of the ammonium chloride combines with retained sodium to produce sodium chloride. Holmgren and Dederding utilize this treatment and in addition keep the patient on the minimum of water, giving sweating treatments, massage, etc.

Due to the possible allergic background of Ménière and the findings of Somygi, that in allergic states there is a depletion of potassium in cells and an increase in body fluids, and that the depletion can be corrected through the administration of potassium with insulin, this treatment has been tried with very good success.

The disadvantage of the Furstenberg treatment is that patients are not happy without salt, for very long, and the continued use of ammonium chloride may produce acidosis and even bone resorption. The very energetic and highly unpleasant procedures of Holmgren and Dederding would not be tolerated by many American patients.

The possible relationship of potassium to sodium retention in Ménière reminds us of the treatment of Addison's disease, in which the large amount of sodium chloride administered is found to be more effective where the intake of potassium is diminished.

Portman's successful operation upon the saccus endolymphaticus would seem to substantiate the theory of increased endolymphatic pressure.

One patient with Ménière, presenting at the time of attacks petechial hemorrhages plus blood in the urine and stool, suggests the possibility of increased permeability of the stria vascularis through C deficiency as one cause of Ménière's syndrome.

In addition to the above, the most important agent in the prevention of neural degeneration in Ménière is vitamin B-complex. In the acute stage, 10,000 to 20,000 units of thiamin chloride and from 100 to 500 mg. of nicotinic acid should be taken orally, and in addition the B-complex should be administered intravenously in amounts suggested by the severity of the attack. Intramuscular use is satisfactory in some cases.*

OTOSCLEROSIS.

Otosclerosis is both a bone disease and a neural disorder — osseous dystrophy and neuropathy. Treatment producing reversal of haliteresis and neural regeneration has proven of value. During three years not one case under treatment has shown further loss of hearing, and a fair percentage have shown definite improvement both in hearing and general health. The routine comprises: 1. diet analysis and regulation; 2. calcium and phosphorus approximately six times the normal requirement; 3. approximately six times the normal requirement of vitamins D, B-complex, C and A.

The disadvantages of the fistula operation which has recreated much enthusiasm during the past year are: 1. the uncertainty of the fistula remaining patent; 2. the formation of intralabyrinthine adhesions which prevent sound waves from passing through even where a positive fistula reaction persists; 3. the fact that the operation utterly ignores the neuropathy of otosclerosis, which can, even in the presence of a permanently patent fistula, produce a progressive loss of hearing, thus rendering the fistula useless. Meanwhile the patient has lost his chance of help through dietary and supplemental vitamin therapy.

*Since the completion of this paper, the successful treatment of Ménière with histamine acid phosphate has been reported by the Mayo Clinic.

Until further experimental work has been done and until those surgeons desiring to operate for otosclerosis acquaint themselves with the fundamental facts of pathology, etc., the operation is inadvisable.

NEUROPATHIES.

Since in the majority of cases of peripheral neuritis there is no evidence of inflammatory reaction, it is now considered preferable to speak of neuropathy.

The attitude of the otologist toward neuropathy of the VIIIth nerve has been an over-simplification, if we are to accept the conclusions of experimental physiologists, biochemists, *et al.*

Excluding degeneration of the VIIIth nerve from direct bacterial invasion as in meningitis, extension from tympanic infection, etc., and those cases due to mechanical influences, nerve deafness has been looked upon as a direct effect upon the neural mechanism of the labyrinth, of toxins from specific etiologic factors. This now seems not to be the case.

The common causes of nerve deafness, excluding bacterial invasion and mechanical factors, are: 1. acute infections such as mumps; 2. tympanic infection; 3. focal infection; 4. drugs, 5. senility; 6. otosclerosis; 7. Ménière.

The end-result of VIIIth nerve neuropathy is the histopathologic picture with which we've been familiar for many years. This is: 1. atrophy of spiral ganglion and Scarpa's ganglion cells with replacement fibrosis; 2. degeneration of the organ of Corti, and less frequently of the vestibular end-organs; 3. disappearance of nerve fibres in Rosenthal's canal and elsewhere.

Of pathogenesis we've been rather unconcerned. The changes which precede the final picture we now believe are: 1. cloudy swelling with ballooning of the medullary sheath; 2. coil formation of axis cylinder; 3. granular disintegration.

Spies¹ reports the histologic examination of the terminal portions of the internal branch of the anterior tibial nerve in 12 cases of deficiency disease with neuritic symptoms. Sections were made both before and months after thiamin therapy. In all cases there was marked loss and degeneration of myelin sheaths. The axons on the whole were unaffected.

This corresponds to the findings of Covell in the study of B-deficiency rats from Evans' laboratory.

A very significant finding of Spies was that as long as 11 months after B₁ treatment was started, there still persisted severe myelin sheath degeneration, suggesting that the quick response to B₁ therapy as to relief of symptoms was biochemical and emphasizing the slowness with which nervous tissue regenerates.

In applying this data to the treatment of VIIIth nerve neuropathy we now realize that treatment should be persisted in for at least 18 to 24 months before concluding that the condition is beyond hope of improvement. Where prompt amelioration of symptoms occurs, we are dealing not with structural change but with the biochemic phase of neuropathy.

F. H. Lewy² reminds us that, despite the manifold clinical forms of neuropathy, such as metabolic, toxic, infectious, etc., its histopathology is basically uniform; namely, cloudy swelling gradually progressing to Waller's degeneration. Now, when we consider the many etiologic factors in contrast to the uniform morbid anatomy, an intermediary link is strongly suggested. This intermediary factor seems to be the liver. All agents which will produce neuropathy act upon the liver. For example, diabetes, pregnancy, hunger, cachexia, pernicious anemia, heavy metal poisoning and infection. The liver becomes depleted of glycogen and vitamin B stock. The glycogen depletion is indicated by increase of ketone bodies and of B-oxybutyric acid in the blood and urine; vitamin B-deficiency, by the increase of pyruvic acid. When more than one-third of the mobile vitamin B stock of the liver has been exhausted, the fixed depot of the nervous system begins to decrease. At this moment the first neural symptoms appear.

One of the first clinical expressions of beginning vitamin B deficiency is increased electrical irritability of peripheral nerves, measured by chronaximetric determination.

There is apparently only one direct factor in peripheral neuropathy if we exclude bacterial invasion and mechanical factors (pressure, etc.). This factor is vitamin B deficiency effectuated through the liver, which is primarily attacked by the various noxious agents and is eventually depleted of its glycogen and vitamin B stock, as well as the other vitamins which do not concern us at this point.

Quoting Lewy further, glycogen stability and lability, and possibly vitamin stability and lability of the liver, represent a familial and an individual constitutional factor in the tendency to nerve disease.

Another mechanism of B-avitaminosis acts through the stomach, the glands of which become affected through neuropathy of the vagus. The glands finally degenerate. In this way a deficiency of an intrinsic factor occurs and the utilization of vitamin orally is interfered with.

What is the exact function of the vitamin B-complex and of what does the complex consist? According to Aring, Evans and Spies,¹ the B-complex comprises: 1. vitamin B₁ (thiamin, aneurin, catorulin), isolated in 1926, synthesized in 1936; 2. nicotinic acid (function in black tongue and pellagra, proven in 1937); 3. B₂ or riboflavin, isolated in 1933, synthesized in 1935, specific relation to cheilitis proved in 1939; B₃, pigeon weight factor (1928); B₄, rat antiparalysis factor (1929); B₅, pigeon weight, rat growth factor; B₆, rat acrodynia factor and rat dermatitis factor (1938); filtrate factor (chick dermatitis) (1935); antigray hair factor (1938); other factors not yet isolated. A complicated, bewildering array, but fortunately in the problem of nerve deafness we are concerned with only B₁ and nicotinic acid, which are the only components of the B-complex which are known to be necessary in the maintenance of normal neurologic function in man.

Vitamin B has to do with protein, fat and carbohydrate metabolism but our interest is mainly in its relation to carbohydrate metabolism and neural change.

Before thiamin can be utilized it must be phosphorylated. In 10 cases of nutritional neuritis, Spies administered cocarboxylase or phosphorylated thiamin; 10 mg. in saline were given intravenously, twice daily. The same improvement was achieved as with thiamin.

In insulin shock therapy there sometimes follows a period of inco-ordination and tremor. It has been shown that if B₁, 3,000 units, is administered a few minutes after the glucose the tremor and inco-ordination do not present. In experimental B-deficiency, after an initial period of hypoglycemia, there occurs hyperglycemia until just before death, when blood sugar again falls.

The glycogen content of the liver is raised by B-complex. The inability to utilize carbohydrates through lack of vitamin B leads to increase of blood sugar, gradual consumption of glycogen reserve in the liver, muscles and nerve cells, and finally to acidosis, as in diabetic coma.

There is with B-deficiency a diminution of tissue oxidation and decrease in nitrogen. Lactic and pyruvic acid appear in the central nervous system. There is loss of appetite, decrease in gastric gland secretion (marked decrease in HCl). Nystagmus, hyperirritability of the vestibular apparatus in the beginning and progressive loss of hearing. Tremor is common. The vegetative nervous system is overexcitable.

One of the writers' patients, with marked impairment of hearing and a pronounced tremor of hands, is, after three years of therapy, including large amounts of B-complex, completely free of the tremor and shows a marked improvement in hearing. Subclinical pellagrins are often called neurasthenics because of fatigue, insomnia, anorexia, vertigo, burning sensations, numbness, palpitation, nervousness, feelings of unrest, anxiety, headache, forgetfulness, etc.

What cases of nerve deafness should be treated and how? Obviously, deafness resulting from bacterial invasion of the labyrinth, as in suppurative labyrinthitis secondary to tympanic infection or meningitis, is hopeless since all neural elements have been destroyed.

Degeneration from explosive noises can only interest us from the standpoint of prophylaxis — avoidance of exposure.

Senile degeneration of the labyrinth is also a problem of prophylaxis. This condition is probably not entirely an old age change but due also to a constitutional factor, plus years of dietary deficiency (B-complex, etc.). To quote Cowgill,³ "There are grounds for believing that American dietaries as a whole are unsatisfactory with respect to the content of vitamin B₁. The examination of available food statistics as well as of recently collected American dietaries, the observations of clinicians concerning the high therapeutic value of vitamin B₁ in conditions hitherto not suspected to be due to lack of this factor, and the observations of the value of added vitamin B₁ to the dietaries of many children, all support this belief. It is believed that prosecution of a program fostering

addition of vitamin B₁ to staple American foods according to the principles discussed in the present report, would be definitely in the interests of the public."

In the treatment of nerve deafness secondary to focal infection we should keep in mind that the removal of the focus should be followed by dietary regulation and intensive vitamin B-complex therapy if we are to give our patients the best chance of improvement.

In otosclerosis which is not only an osseous dystrophy but also a neuropathy, the results of B-therapy during the last three years have convinced the writer of its value. Particularly is this so during pregnancy, at which time the requirement of vitamin B is five times the normal where no otosclerosis exists.

In acute infectious diseases the systemic need for vitamin B again is much greater than normally and its administration not only supplies the additional systemic need but serves as a preventive of VIIIth nerve involvement. In such conditions as mumps, measles, scarlet fever, typhoid, etc., the patient should receive at least 3,000 to 4,000 units of thiamin and 100 mg. of nicotinic acid daily, in addition to other vitamins and special dietaries. Probably much larger doses will eventually be found to be indicated.

In the initial active stage of Ménière's syndrome, where the imminence of neural degeneration is the most serious of all factors, the patient should receive, in addition to the usual treatment, large amounts of vitamin B-complex in the form of B-complex rice syrup or brewer's yeast, 10,000 to 20,000 units of thiamin chloride and 100 to 500 mg. of nicotinic acid daily. In addition, B-complex should be administered intramuscularly or intravenously.

Borsook claims that more than 3,000 units of B₁ daily is futile as the amount over 3,000 will promptly be eliminated. On the other hand, Spies advises 50 to 100 mg. of B₁ daily. This means 15,000 to 30,000 units.

All components of B-complex are harmless regardless of dosage. Nicotinic acid in doses over 25 mg. at one time may be accompanied by abdominal pain and flushing of the face, elbows, etc. B₆ sometimes produces itching.

Aside from the prevention and treatment of neuropathy with B-therapy, the systemic effects are most gratifying.

Patients who have been placed upon adequate diet with the required vitamins, almost without exception note improvement in general health: appetite increases, the under weight gains, constipation is relieved, tremors disappear, increased emotional stability occurs, thin, brittle finger nails become strong, etc.

While improvements in general health depend, of course, upon the nature of pre-existing defects, a rather characteristic statement of a patient, age 60 years, is presented. The diagnosis is VIIIth nerve neuropathy resulting from a large amount of quinine taken at the age of 30 years. A completely unexpected improvement in hearing has occurred.

While the actual decibel improvement is not great, it has made an enormous difference in the patient's life.

Treatment consisted of thiamin chloride 4,000 units, 100 mg. nicotinic acid, eight brewer's yeast tablets (later four) daily and a carefully planned diet. After six months of treatment this patient stated: "I am capable of doing much more work than formerly. I have more endurance. For 30 years I had to take psylla seed, mineral oil and a daily enema. Now, and ever since the treatment was started, I have had a natural movement every day. My appetite is better. I have to curb it because I don't want to gain. My hearing is better. I used to have nose bleed monthly but not once since I began treatment."

Although the effect of vitamin B has been stressed, we must keep in mind that all patients have received adequate dietaries and fully adequate amounts of vitamins A, C and D. Whether the improvements in hearing, tinnitus and general health have accrued from B mainly or from the other vitamins or from the adequate diets; or whether the combined therapy is the answer, we are unable to say. In some cases liver extract in 0.5 cc. doses has been injected twice weekly, and in still others five units of insulin have been used with the thiamin chloride.

The astonishing effects of vitamin A-deficiency in young dog experiments of Mellanby⁴ open up a new field of thought

and research. The effects reported are: 1. degeneration of cochlear nerve and spiral ganglion cells; 2. degeneration of the vestibular division of the VIIIth nerve; 3. overgrowth of bone in the modiolus, etc.; 4. serous labyrinthitis with degeneration of organ of Corti and Cristae ampullaris; 5. overgrowth of bone in base of skull, with degenerative changes in other cranial nerves, such as optic and trigeminal. Mellanby believes the new bone formation, through compression, produced the changes in the VIIIth nerve fibres and ganglion cells, and that the Corti degeneration followed the serous labyrinthitis.

Of course, Mellanby's experiments will have to be substantiated by the work of others before the results can be placed upon the firm level that the antineuritic vitamin B, and nicotinic acid have attained through innumerable experiments, both animal and clinical.

One remembers the furor created some years ago by the Swedish investigator who reported that cod liver oil produced marked myocardial degeneration in rats. His report comprised a good size volume, with excellent photomicrographs of badly damaged heart muscle. When his work was carefully scrutinized, it became clear that his rats probably presented the above pathology and additional ones, not from cod liver oil but from very inadequate diets. When his experiment was repeated with rats on proper diets, no myocardial changes occurred, regardless of how much cod liver oil was given.

Summarizing: To the final pathologic picture of nerve deafness, with which we are so familiar, must now be added the whole of pathogenesis beginning with the primary mobilization of vitamin B fixed stock in the nerve; the presence of pyruvic acid, diminished chronaximetric reaction (hyperirritability)—the biochemic phase: then cloudy swelling, myelin degeneration, coil formation, distintegration—the structural phase. We must keep in mind that the center of interest, primarily, is the liver with its glycogen and mobile B stock, and that neuropathy is closely related to carbohydrate metabolism.

Conclusions: Certain types of nerve deafness are preventable through adequate dietaries and adequate vitamin intake, with appropriate increase during illness and pregnancy.

Certain cases of VIIIth nerve involvement with loss of hearing can be benefited with vitamin therapy. Improvement in general health usually occurs with or without favorable VIIIth nerve change, where a carefully planned program is followed for sufficient time.

In the biochemic phase of neuropathy, improvement may occur within a few days. Where structural changes are present, treatment should be persisted in for 18 months or longer.

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CRESATIN IN LARYNGOLOGY AND OTOTOLOGY.

DR. M. D. LEDERMAN, New York.

Having had a number of inquiries in reference to the use of cresatin (metacresol acetate) in otolaryngology, and as my original paper on this effective antiseptic and analgesic in diseases of the nose, throat and ear appeared some years ago (*THE LARYNGOSCOPE*, March, 1911), I thought it might be of some interest to the present generation of otolaryngologists and dental surgeons to direct their attention to the satisfactory therapeutic activity of this remedy. It is offered as a valuable substitute for carbolic acid and the cresols as cresatin possesses the well known bactericidal and analgesic properties without their irritating and escharotic action. Cushny (*Pharmacology and Therapeutics*, 1910) states that metacresol is less poisonous to mammals and less irritant and at the same time seems to be more destructive to microbes than carbolic acid.¹ To quote from my original paper: "Cresatin is the acetic acid ester of metacresol, and contains metacresol, which is the least toxic of the cresols and less toxic than carbolic acid.² It is characterized by the antiseptic and analgesic properties of metacresol without the objectionable caustic feature. Being less of a coagulant of albumen, its penetrating power should be more decided than that of the free phenols.

Cresatin is soluble in animal and vegetable oils and fats, also in alcohol, but practically insoluble in water. It is stable, does not discolor or undergo change in keeping. Being a definite chemical compound, it is uniform and can be heated to high temperatures without decomposition."

In furunculosis of the external auditory canal, cresatin was applied in full strength on cotton tampons. The canal was previously cleansed with alcohol, and the saturated tampons were then placed firmly in position over the infected area. This treatment may be repeated every two or three hours by the patient if pain persists. Cresatin is very effective in this infection.

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A soothing sensation of warmth is experienced, which is soon followed by a feeling of relief from the previously existing pain. The analgesic action is promptly observed. In some of the cases, where suppuration had not appeared, pus was seen on the tampons after a few applications. In other patients, the tumefaction gradually subsided without visible evidence of pus and with no recurrence of the infection.

Pleasant results were obtained in eczema of the external canal, especially where the symptom of itching was very annoying. The parts were first dried and cleansed of epithelial debris, and cresatin was painted over the affected areas in pure form. In some patients prompt relief was experienced, but in the more chronic variety a few applications were required before the desired result was noted. For home application a 5 per cent cresatin in adep. benz. ointment was prescribed.

In chronic purulent otitis media, after thorough cleansing of the canal and middle ear, the preparation was used rather freely, through the perforated membrane, before iodine powder (Sulzberger) was applied. After a few treatments in this manner, the purulent discharge lessened and gradually ceased. In cases of cholesteatoma of the middle ear and mastoid, accumulation of ceruminous and epithelial debris does at times cause irritation of the neighboring skin. Two or three applications of cresatin, after removal of the foreign material, generally ends this local disturbance.

On account of its antiseptic and penetrating action, I have employed cresatin in a few cases of atrophic rhinopharyngitis. The parts were first thoroughly cleansed of dried secretion, which is a necessary procedure in the proper treatment of this unpleasant and stubborn disease. The medication was then applied with considerable friction—in full strength, by means of a cotton applicator—to all accessible areas. Postnasal paintings were also given. The mucous membrane responded promptly to the stimulation, and the patient remarked that the parts felt moist and comfortable for some hours after the treatment. Most of these cases were clinic patients whose attendance was irregular, so no definite conclusions could be reached. In two private individuals who received rather regular attention and who used, also, a 25 per cent cresatin olive oil solution at home, decided improvement was noticed.

Home treatment in this obstinate and unfortunate affection must be a necessary adjunct. In the patient's hands a forcible atomizer* will probably give better results as the medication will reach a greater area than by simple application.

Cresatin has been used in acute follicular tonsillitis with considerable success. It has been found, also, that the duration of the affection is shortened by direct application in pure form, thoroughly rubbed into the follicles after removal of debris. The analgesic and antiseptic effects in these cases makes it of decided value.

It is of considerable service in painful lesions about the lips and mouth; *i.e.*, herpes facialis, fissured lips, aphthous stomatitis, Vincent's angina and in dental manifestations. It has been used with prompt effect in gumboils, after the pus was drained. In 24 hours in many cases no further unpleasantness was noticed. The cresatin was applied between the tooth and the gum. After incising and draining peritonsillar abscesses, application of cresatin to the cavity assists materially in curtailing the infection.

In cases of folliculitis of the nasal vestibule, a few treatments with cresatin gave the desired relief without surgical intervention.

Dr. E. J. Whalen³ and Dr. Wm. D. Gill⁴ have corroborated the effective activity of cresatin as a local application in otomycosis. In papers upon this subject, they and other observers have had satisfactory results in puritus in the ear and in other regions of the body.

In a paper on "Gonorrheal Ophthalmia," Dr. Cyril Barnert⁵ published a series of cases of this serious disease, in which cresatin was employed after local anesthesia, in which he claimed striking results.

Not having had any personal experience with its use in eye diseases, would suggest that additional observations in this field be made in order to further study his reported results in these cases.

Before concluding these desultory remarks, it may be of interest to mention the pleasant effect of this analgesic anti-

*It is best to use an atomizer, all parts of which coming in contact with the preparation are made of glass.

septic in cases of tubercular ulceration of the epiglottis and larynx where cresatin decidedly relieved painful deglutition.

Cresatin alone, or combined with the essential oils of eucalyptol, pine needle or peppermint, with which it is readily miscible, should prove very effective in the treatment of infectious diseases of the upper air passages. It may be used by means of glass atomizers, vaporizers or by steam inhalations.

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NEW YORK ACADEMY OF MEDICINE.

SECTION ON OTOLARYNGOLOGY.

Meeting of Dec. 20, 1939.

Pharyngomaxillary Fossa Infection. Dr. Raymond J. Gaffney (by invitation).

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

The Use of Colloidal Thorium Dioxide in Roentgenography of Paranasal Sinuses. Dr. Russell C. Grove.

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

Meningitis and Temporal Bone Abscess Secondary to Suppurated Petrositis. Clinical Course with Sulfanilamide. Dr. Eugene R. Snyder.

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

Cerebrospinal Rhinorrhea. Pathological Findings. Dr. Max L. Som and Dr. Rudolph Kramer.

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

Polypoid Tumors of the Esophagus. Dr. John J. Mahoney (by invitation).

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

Two Cases of Esophageal Foreign Body with Complications. Dr. F. Vistreich.

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

Osteogenic Fibrosarcoma of the Temporal Bone. Dr. Harold W. Corya.

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

Sphenotemporal Lobe Abscess with an Analysis of Little Known Symptoms. Dr. David L. Poe (by invitation).

(To be published in a subsequent issue of THE LARYNGOSCOPE.)

(Continued from July issue.)

DR. RUDOLPH KRAMER: It is rather late and I don't want to take too much time, but I would like to point out a couple of factors that interest me particularly.

For some time we have been emphasizing the value and necessity of doing serial sections on sinus blocks in cases of intracranial complications, even though there is no antemortem evidence of sinus involvement. We found a number of very interesting unsuspected conditions in doing these sinus blocks. It is not likely that the men in any one hospital are going to get enough material in a fair number of years to afford them the opportunity for the study of a sufficient number of examples of the various types of lesions. As a

result, we must all pool our findings. For instance, these are the only cases of cerebrospinal rhinorrhea that we have encountered at postmortem and in which we have been fortunate enough to get serial sections.

Serial sections take a lot of study, but the labor and the time are well spent because of the discovery of the pathological processes present, the pathways of infection, and the suggestions that one gets in the way of therapy. I have learned a good deal, I think, from the scanty material we have had, in the treatment of suspected complications. I have an idea that the next time I see a patient, such as Case 1, with cerebrospinal rhinorrhea I shall have definite thoughts as to the therapy.

The therapy in Case 2 seems at present to be hopeless; apparently nothing, including large doses of chemotherapy, will prevent a fatal termination. But in a case of dural polyp such as the first, I feel that there may be justification for a frontal approach in an effort to save some of these people from death.

DR. ARTHUR PALMER: Certainly one of the most interesting chapters in bronchoscopy is the one written on foreign bodies. One cannot deny that the surgeon who succeeds in removing a foreign body which is a menace to the patient's life has rendered a great service. Sometimes removal is quite simple but more often it is difficult, dangerous, and constitutes an ordeal both for the surgeon and for the patient.

These two cases which Dr. Vistreich has reported illustrate principles which apply in all of these cases. I believe we learn more from cases which terminate fatally. One thing we ought to keep in mind in connection with possible foreign bodies is the heeding of the patient's complaints, not passing off his story lightly, telling him he probably has a scratch—to swallow food, or keep on attempting to swallow even in the presence of the possibility of a foreign body—but rather to investigate conditions thoroughly with fluoroscopy and X-ray examination, and if these prove negative, but there is still a probability of the presence of some foreign body, by direct examination.

Another principle which we learn from the fatal case particularly is the danger of delay. The man who died as the result of his foreign body came to the hospital three or four days following its ingestion. He was a neurotic person, known as such to the family doctor for many years, and when the family doctor was informed of the situation he believed that he was again dealing with a neurotic complaint. He became aware of the seriousness of the condition when the man developed a temperature and signs of mediastinitis. We have all seen neurotic patients in the clinic, and we are inclined to pass up minor symptoms too hurriedly. The neurotic patient may still have a foreign body which may kill him.

The third principle concerns X-ray examination. It is exceedingly valuable in most of these cases, and fluoroscopy as well, but at times we are led astray when the foreign body is not visualized, usually because of its location underneath the sternum. Such was the condition in the second case described. No foreign body was visualized by X-ray, and at the time of the examination by esophagoscopy there was so much reaction in the form of edema and ecchymosis that it was impossible to visualize it. I recently saw a woman from a neighboring town who gave a history of eating scalloped potatoes at a church social the previous evening, and since that time had had a sensation of something in her throat. She was not particularly uncomfortable and she could swallow, but she felt conscious of irritation and a feeling as of a mass. She was anxious to get him, but I persuaded her to stay until we could have a fluoroscopy and X-ray examination, which were reported negative. Then I made the mistake of allowing the patient to go home without further examination, telling her to return if the symptoms persisted. Much to my chagrin, she wrote me a letter saying that following a vomiting spell, she had evacuated a large piece of cellophane. I feel that if we had gone ahead with direct examination we undoubtedly could have found this material and removed it.

I agree with previous speakers with respect to surgery, in that if there is a perforation of the esophagus with threatened mediastinitis, it is much better to externalize the esophagus early, rather than to delay and lose valuable time waiting for Nature to make a channel for the evacuation of pus.

DR. JOHN D. KERNAN: I hope I won't be out of place if I report a very remarkable case. I was going to say about the program word for word what Dr. Loré has said, which I consider a remarkable case of telepathy.

In regard to abscesses of the neck, I think it is very important to evacuate them as soon as possible. I saw two cases of mediastinitis in one winter secondary to abscesses in the neck, so there is no doubt that at times pus does start down the neck and go all the way to the chest. I recall half a dozen other such cases. There is another point about going early after pus, and that is to limit suffering. Patients with abscesses of this kind suffer a great deal. We all know that they may be nursed along until the pus points, but if you can find it a week sooner, or 10 days sooner, it limits suffering a great deal; and not only that, it also prevents death at times.

About Dr. Groves' case, I don't recall it very well except for this—the antrum was full of polypoid tissue, and that polypoid tissue was very vascular, causing a furious hemorrhage during removal, which in the end was controlled only by the tightest packing. I think it was 10 days later that the packing was removed, and then the man had a secondary hemorrhage.

The first case that Dr. Mahoney reported of polyps on the basis of carcinoma, I think, shows that the man must have had the carcinoma first and that the polyps then arose from shutting off of the lymphatic drainage, just as occurs in chronic inflammation of the nose or sinusitis. Now, we had a hard time diagnosing that case, as you will see from the report. The mass didn't look like anything I ever saw through an esophagoscope—it looked like a bunch of grapes of different sizes. The first biopsy showed polyposis; the second, carcinoma; the third, again polyposis; and it was only after the man had died and we had an autopsy that the diagnosis of carcinoma was finally confirmed. You may say, what is the use of making a diagnosis in a case that is going to die anyway? Unless we make a correct diagnosis we will never get ahead with therapeutics, so that we should always try for one.

As for Dr. Mahoney's second case, you will note that Dr. Mahoney said these cases are always pedunculated. This one was not. I tried to pass a wire over this tumor and it proved to have a broad base. When I did the second esophagoscope I put in the radon seeds and the man was relieved of difficulty in swallowing. I flattered myself very much that I had relieved him with radon in a case of polyps with dysphagia until I esophagoscoped him again a year later and found that the polyp was as big as ever. Then I realized that it must have been the stretching that had relieved his difficulty in swallowing, so that he was not cured by radon, but by stretching his cardia.

The third case was one of straight carcinoma. He was rather interesting. (Blackboard drawing showing polyp with descent of barium.) If you will recall the lantern slide, a solid column of bismuth or barium had come down this way and surrounded the polyp. Biopsy showed a carcinoma, and we planned to do a transthoracic resection of the lower end of the esophagus, but when further investigation was made it was found that the whole cardiac end of the stomach was a mass of cancer, so that the esophageal growth was just a little offshoot of the main mass.

DR. JOHN M. LORE (Dr. Corya's case): I had the privilege and pleasure of discussing this case at the Manhattan Eye, Ear and Throat Hospital. We had a parallel case at St. Vincent's, one of osteogenic sarcoma, and I showed some of the slides to Dr. Eggston. The symptoms in this case were entirely different because of a different location. The clinical picture in our case was one of blurring of vision, pain, eventually complete loss of vision, proptosis, more pain. An X-ray was taken elsewhere and the report was "pansinusitis

on the involved (left) side." The patient was referred to St. Vincent's for possible sinus surgery. When I saw the X-ray I was impressed by one thing, and that was the inequality of the sphenoid fissure of the two sides. We decided that we had better have stereoscopic films taken. We noticed asymmetry of the vault of the nasopharynx, but it was on the right side, not on the left where the blindness was. We tried to figure out why this should obtain on the right side and still the symptoms be on the left. We found later that she had a large mass which involved the nerve and orbit on the left side but was at a lower level on the right side. X-rays taken at St. Vincent's showed erosion and destruction of the lesser wing of the sphenoid and part of the sphenoidal fissure. Further examination revealed a mass between the middle turbinate and septum. The edge of the mass looked rather hemorrhagic, and we performed a biopsy. At the time we did so I was saying my prayers, for I was in mortal fear of producing hemorrhage. I thought that from the feel of it, it was a sarcoma. It felt a great deal like rubber, and she did bleed quite hard. The report came back, "osteogenic sarcoma." From the clinical picture we did not feel justified in attempting surgery, but felt that radium might help some, although it was the first such case we had seen. She later developed blindness in the other eye. Eventually she died at home.

In making foreign body diagnoses—nonopaque foreign bodies particularly—a little stunt can be tried. If plain barium or bismuth does not work and you still suspect something, try a moderately large capsule with barium or bismuth, and if that stops you are perfectly justified in going ahead and doing an exploratory esophagoscopy.

DR. JACOB L. MAYBAUM: The case reported by Dr. Corya of osteogenic fibrosarcoma of the temporal bone was in the advanced stage when first seen by him. At Mt. Sinai Hospital over a period of 18 years we have had six neoplastic ear cases arising primarily in the ear canal or middle ear. Three of these came under our observation within one year. One was a fibrosarcoma in the early stage in a woman, age 50 years. She had a facial palsy which was intermittent in character. There was marked otalgia, and on examining the ear one could see a firm mass deep in the canal. There was no evidence of middle ear or nasopharyngeal involvement. This combination of events—intermittent facial palsy, otalgia without middle ear or nasopharyngeal disease, and a mass in the ear canal—is quite characteristic of the early neoplastic middle ear or external canal disease. Biopsy showed a fibrosarcoma. Our first inclination was to operate, but our radiotherapist advised us that these tumors are radiosensitive and if treated in the early stages respond very readily without operative intervention. Under X-ray therapy this patient rapidly improved. It is four and one-half years now since treatment was first given. The symptoms have disappeared and the mass is entirely gone.

The prognosis in a fibrosarcoma of this location in an adult when seen early and properly treated is good, but the reverse holds true in children.

DR. JACOB L. MAYBAUM (Dr. Poe's case): Dr. Poe is to be commended upon the good judgment he used in the management of this case and upon the splendid outcome. In my opinion, and I believe the majority of otologists agree, it is in the best interest of these patients to have a cranial surgeon in constant attendance as soon as a suspicion of a brain abscess is entertained and long before the question of surgery arises, so that both the cranial surgeon and the otologist can follow the clinical course. By and large, I believe better results are obtained by turning these patients over to the cranial surgeon as, necessarily, they can cope with the surgical problem more expertly. We are rather loath to operate on these cases unless there is an actual rupture of the abscess into the mastoid, and even in such instances we have recourse to close co-operation with the cranial surgeon.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

SECTION ON OTOLARYNGOLOGY.

Meeting of Dec. 8, 1939.

Osteomyelitis of the Skull, Dr. John J. Hochfilzer.

Dr. John J. Hochfilzer gave a talk on "Osteomyelitis of the Skull," showing X-ray films and presenting his case.

There are two interesting factors which I believe make it worth while to report this case; namely, the mode of infection and the different phases of bone regeneration.

This boy, now age 14 years, has been sick more or less for seven years, suffering from intermittent severe attacks of bronchial asthma, which necessitated hospitalization at various times. There was also some clinical evidence of a mild inflammatory right antritis; therefore, it was thought bacterial allergy may also be a factor in the case. Repeated lavage of the right antrum revealed some mucopurulent material and usually improved patient's condition.

During one of his stays in the hospital, in August, 1938, he acquired an acute follicular tonsillitis, with an elevation of temperature to 103°. The culture from the tonsils showed streptococci and staphylococci; throat irrigations and administration of sulfanilamide improved his condition rapidly and he was discharged on Sept. 9.

About one week later he developed severe pain over the right forehead, radiating to the right parietal region, with elevation of temperature to 104°. At that time no local symptoms could be elicited except extreme tenderness over the involved area. One week after the onset of the pains a swelling appeared over the right frontal ridge, gradually involving the right upper eyelid; a considerable amount of inflammation appeared with it.

X-rays were taken (by Dr. Hanson) which showed osteomyelitis of the right frontal bone involving the inner and outer plate. The sinuses were negative (X-ray picture No. 1 by Dr. Hanson).

The question now was, which course of treatment to follow; the radical one, that is, removal of all diseased bone, or the conservative one, evacuation of the subperiosteal abscess only and further observation. The latter course was decided upon.

Under gas anesthesia, an incision was made at the region of the right upper orbital ridge, about 5 cm. long. About two ounces of creamy pus were evacuated. In palpating the bone, it was found to be bare of periosteum. One 1-inch iodoform pack was inserted; 25 per cent argyrol inserted in the conjunctival cul de sac, and sterile dressings.)

Culture of pus from this abscess showed pure growth of staphylococcus aureus. (No growth of fungus after three days' incubation.)

The local symptoms, swelling and inflammation of upper orbital ridge subsided, and patient left the hospital several days later, but it was soon evident that the process of bone necrosis was spreading, manifesting itself by increasing edema of the skin of the forehead, which soon had reached the hair line and went beyond it. He had moderate amount of pain and the temperature was slightly elevated. X-rays were taken on Oct. 27, 1938.

("Posteroanterior stereoscopic films were made of the sinuses and skull, and right lateral stereoscopic films of the anterior half of the skull.) The entire right frontal bone shows marked destruction, characterized by numerous confluent, rather well defined round, oval and elongated areas of bone absorption. The involvement extends slightly beyond the coronal suture and slightly over the left side. (It also includes the lateral part of the right frontal sinus and the right orbital margin. The involvement appears to be more marked on the inner table than on the outer, but the anterior table is very definitely involved in the region of the frontal sinus. The remaining sinuses are clear.")

The X-ray findings and clinical evidence left no doubt that the process was rapidly spreading and radical measures had to be taken.

Under intratracheal anesthesia, an inverted "T" incision was made, starting close to the vertex and extending to the root of the nose. Horizontal incision was made from the root of the nose to the outer canthus of the eye on each side. The skin flap was turned back and the periosteum removed from the frontal bone. About 2 cm. above the orbital ridge, necrosis of the bone about the size of a dime was found. At that point the bone was removed. Immediately after the cortex was removed, about one ounce of pus welled up from the extradural region. With the rongeur the bone was removed around the necrotic area, and it was found that the dura was covered with a layer of exudate about the size of a silver dollar. In all these areas the diploic space of the bone was found filled with pus. Nearly all of the frontal bone on the right and some of the left was removed; reaching the suture line, another extradural abscess was found and so part of the parietal bone was also removed. Both frontal sinuses were explored but no pus found. Three soft rubber drains were inserted, the skin flaps turned back and anchored with silkworm.

Culture from extradural abscess showed pure growth of staphylococcus. The postoperative course was much smoother than one would expect it to be after such an extensive procedure; patient was weak and restless for the first two days; he received four blood transfusions; the wound drained profusely in the first week. He was discharged from the hospital three weeks after the operation. The wound gradually healed, a fistula persisted for three months from the frontal sinus proper, but that has closed also. He now feels fine and has gained 15 pounds.

In the matter of etiology, most apparent is the spread of infection by continuity of tissue following operation upon the frontal sinuses. But no surgical procedure whatever was done in this case at the time (the lavage of antrum was at least six months previously); therefore, infection by continuity may be ruled out. The second mode of extension is that of hematogenous metastasis. The infection may be carried to various bones of the cranial vault through the blood vessels supplying these tissues. In this case the focus of infection was the acute tonsillitis, from where it spread through the blood stream to the cranial vault; additional proof of this was the findings in the frontal sinus, where no evidence could be seen of any inflammatory process.

Statements have been made to the effect that flat bones of the skull do not regenerate. Furstenberg, in his work on osteomyelitis of the skull, described in detail the histologic phases. He states, if only fragments and shreds of traumatized periosteum remain, they will form the base of an embryonic character, in which ossification may follow. In this case we have ample evidence of bone regeneration and the X-ray pictures show plainly the islands from where ossification starts. I believe the whole defect may be filled in by new bone in another year.

DISCUSSION.

DR. CARL L. LARSEN: Edema is a very important symptom. It is pathognomonic of osteomyelitis. It will show you with surprising accuracy the extent of bone involvement. I think that over 90 per cent of cases are caused by continuity from infected sinuses.

I saw a case last spring in a boy, age 18 years, who had had a swelling of the forehead for several weeks. When I saw him, he had a fluctuating swelling

of the upper portion of the forehead. X-ray showed a very small area of osteomyelitis. The abscess was opened. X-ray in a few days showed an increased bone involvement. We decided on immediate operation. Both frontal sinuses were filled with pus. All apparent diseased bone was removed. An opening of about 2 cm. was found in the inner plate. In a few days the boy died of meningitis. Autopsy showed that all apparent necrotic bone had been removed. There was a large accumulation of pus beneath the dura of the entire left hemisphere.

These cases are very treacherous. They must be diagnosed and operated early if life is to be saved.

DR. ERLING W. HANSEN: About 12 years ago, when on the ear, nose and throat service at the university, I had a case of osteomyelitis of the frontal which had been going on for a good many weeks—apparently had taken care of itself. The boy, age 19 years, had been treated for frontal sinusitis. He had a very rudimentary frontal on the involved side, with no connection between that and involvement of frontal bone. In area it was about as extensive as Dr. Hochfilzer's patient, but involved only the outer table, so that practically all that was necessary to be done was picking off sequestra of bone with forceps and curette. I am interested in knowing from your experience or from the literature how many of these can be ascribed to extension from frontal sinus, and how many are hematogenous.

DR. HAROLD J. ROTHCHILD: I had a case of similar nature two and one-half years ago—a boy, age 17 years. There was a history of severe headache and purulent discharge following swimming. It is interesting to note that many of these cases of osteomyelitis follow swimming. This case involved the frontal sinus of the right side. He had a convulsive seizure prior to going to the hospital, and after arriving there he had another convulsive seizure. An external opening in the right frontal sinus revealed thick pus and pyogenic membrane. He was very septic, very sick, and after about 10 days he began to show slight improvement—when a little swelling seemed to occur over the right frontal bone. X-ray at that time showed practically no involvement of the frontal bone. Again, it is interesting to note that the external manifestation seemed to precede the X-ray appearance of bone involvement by about 10 days to two weeks; however, epileptiform convulsive seizures followed the edema. I considered it advisable at that time to wait several weeks for the condition to localize. About a month later we went in and did a resection of the frontal bone. Both external and internal tables were involved. The bone was soft as far down as we could go, involving the upper margins of both orbits and the roof of the right orbit. We resected the bone down as far as possible—we considered it inadvisable to go further (upward about 5 or 6 cm. above brow). An area of the dura over the right frontal lobe showed granulation. The fact he had had a number of convulsive seizures made me suspicious of a frontal lobe abscess, but an incision through the dura failed to reveal pus. He had a very, very stormy convalescence, and a fistula which finally healed, and today the young man is a great big strapping fellow, six feet two inches, going to school, feeling quite well except for occasional convulsive seizures which are kept under control with barbiturates. Bone seems to fill the portion resected to a good level, except for an area about 4 cm. in diameter which is thinner. Here there is a slight depression. In general the cosmetic result is very good.

DR. LAWRENCE R. BOIES: I brought along some photographs and X-rays of a case which came back to the University Hospital for a follow-up examination last week. Three years previously, this man, age 28 years, had been operated for an extensive spreading osteomyelitis of the frontal bone. It had followed an acute exacerbation of a chronic bilateral pansinusitis with extensive polyposis. As you can see from the photographs and from X-rays taken after the bone was removed, our surgical treatment was radical and extensive. While convalescing from the first operation, the patient developed an infection of the right maxilla. This was treated conservatively by awaiting sequestration, after which pieces of necrotic bone were removed. These pieces included the front wall of the antrum and the floor of the orbit anteriorly. The patient was in the hospital for a total of about 11 months.

At this time he appears to be well and has complete regeneration of the frontal bone. It is flattened, however, and he has extensive scarring. He now wants to consider plastic improvement of his scars, but he will postpone this for another year.

We have had two additional cases of spreading osteomyelitis of the frontal bone operated in the past three years at the University Hospital by the same radical method of getting beyond the line of edema and not waiting for X-ray evidence of destruction. One was in a girl, age 18 years, and the other in a boy, age 12 years. Both were cured and in each regeneration of bone is complete. The bacterial findings in the man, age 28 years, and the 12-year-old boy were staphylococcus aureus and a nonhemolytic streptococcus in each case. In the case of the 18-year-old girl, cultures of the pus showed a staphylococcus aureus.

In line with the subject we are now discussing, there arises the question of what to do or not to do in an acute fulminating frontal sinusitis. We were discussing this informally one day and Dr. Phelps suggested that if he were afflicted he would want a simple trephine externally to insure adequate drainage. Soon afterwards a case came in to fit the situation. A student, age 20 years, developed persistent severe frontal headache during an attack of influenza, and when I saw her a week later she had a fever of 102° , clinical evidence of an acute left frontal suppuration in a moderate-sized sinus and edema of the upper eyelid. We decided to make a small incision in the upper lid and trephine through the floor. This was easily done by Dr. Hilger, who was then the Senior Fellow on the service; a free flow of pus resulted. Recovery followed rather promptly and it was unnecessary to carry out any other therapy. The small external scar is now scarcely noticeable.

DR. VIRGIL J. SCHWARTZ: This is the second case which Dr. Hochfilzer has reported; both resulted in cures. The most significant fact in Dr. Hochfilzer's present report is the fact that the disease did not originate in a suppurating sinus; most of these are found to start from this source.

During the last three years I have seen two cases of osteomyelitis of the skull. One began in a maxillary sinus; the organism was a staphylococcus hemolyticus. The involvement spread from the nose into the malar bone and eventually involved the entire orbital margin and adjacent areas of the skull. That was before the discovery of sulphapyridine, and I am wondering whether or not this drug would have helped. The second was a boy, age 17 years, who had developed an acute purulent pansinusitis after swimming. He was moribund when we first saw him. Respirations were eight per minute and there was a high spinal fluid cell count indicating definite meningeal involvement. Although it seemed useless, we felt that something should be done, so we took him to the operating room and by the external route opened all the sinuses of the right side and the left frontal. To our great astonishment, the boy eventually became conscious and slowly began to improve. Osteomyelitis of the skull developed, requiring extensive removal of the bone. We did not get as good a cosmetic result as Dr. Hochfilzer has; his patient has excellent contour of the skull, because the involvement is in the form of a long, straight strip near the midline, which can be bridged across without much deformity. My patient, as Dr. Boies stated, has a flat depression, due to involvement of the lateral as well as the superior aspect of the skull. Dr. Adson, who did most of the bone removal, is going to build this up by means of an implant of some sort. The boy is now quite well and is going to school.

DR. JOHN J. HOCHFILZER (in conclusion):

1. It is not necessary to do major surgery on nasal accessory sinuses to cause osteomyelitis; minor surgical interferences such as removal of nasal polyps, antrum irrigation, may produce osteomyelitis.
2. In regard to the etiology, in 90 per cent of the cases we find a staphylococcus as the offending bacteria.
3. The reason for a better contour of the frontal bone, I believe, is to be found in the fact that the patient is still in the growing age.

Meningioma with Invasion of the Frontal Sinuses. Dr. K. C. Wold.

I wish to report a case of meningioma with invasion of the frontal sinuses, in which osteomyelitis of the frontal bone was suggested as a differential pre-operative diagnosis.

This patient, a woman, age 65 years, was first seen on Nov. 14, 1933. During the past five years she had noted a slow-growing swelling in the frontal area. Her past history was negative except for some nose and ear trouble 20 years before, for which she had received a few local treatments. There was no history of trauma.

Examination revealed a large lobulated mass extending over the frontal region. In width it was 6-8 cm. On palpation it was found to be soft in the central portion and there was a distinct crackling on pressure. The preoperative diagnosis was carcinoma of the frontal sinus, or a large mucocele. X-ray examination verified the presence of a tumor in the sinus but also suggested inflammatory disease with osteomyelitis.

Surgery was indicated, and two days later, under a general anesthetic, a radical operation was performed. A Killian incision was made over both frontal sinuses and was extended nasally and inferiorly to cross over the bridge of the nose. This entire flap was then lifted upward to expose the tumor mass. Parts of the external plate of the frontal bone which had not eroded were found in several places, firmly adherent to the tumor tissue beneath them. The entire mass was then dissected away from the inner plate and floor of the sinuses. The mass was found to be lobulated, quite hard and fibrous in most portions, but with one large area being soft and polypoid. The posterior wall of the cavity was almost sieve-like from the erosive action of the tumor, entrance to the sinuses having been effected through many of these areas. The cauliflower mass was then removed, rubber drains inserted into each side of the nose through the nasofrontal ducts, the periosteum closed with mattress sutures, the frontal flap replaced and silk sutures placed in the skin for closure. Five hours later the patient expired, apparently from shock.

Autopsy findings were those found at operation. In addition, the brain was found to be adherent to the brain-case in the frontal region, and a large, round, solid but partially necrotic tumor was found occupying the greater part of the tip of the frontal lobe. Tissue examination by Dr. John Noble determined that this tumor was a meningioma.

(Largely excerpts from Cushing's book, "The Meningiomas"): Meningiomas probably arise from the cell clusters principally associated with the arachnoid villi, which in later life develop into the Pacchionian granulations. As they grow they expand in the line of least resistance, molding themselves around blood vessels and crowding their way into all neighboring anatomical crannies and pockets. In type there are four: fibromatous, cellular, sarcomatous and angiomatous-like. They appear never to give metastases, even the sarcomatous type. The course of these tumors is slowly progressive. Pressure symptoms are late in appearance. The tumor coming into contact with bone usually causes pressure rarefaction and sometimes penetration, although in a large group of cases the contiguous bone is involved by strands of tumor cells to produce an extensive hyperostosis which may seem to form the core of the tumor. They may arise anywhere from the meninges, but the parasagittal site is the most common. In Cushing's group of 313 cases, 65 were in this location, the convexity of the vault in 54, the sphenoid ridge in 53, the olfactory groove in 29, the suprasellar region in 28, the posterior fossa in 23, eight from the temporal, seven from the falx, five Gasserian and one infraorbital. Meningiomas are rare in both old age and childhood. They are 50 per cent more common in women. Trauma seems to be an initiating factor in a high percentage of cases. In only one of Cushing's group of 313 cases was the frontal sinus found to be invaded. This tumor had arisen from the anterior falx region and by pressure had eroded the posterior wall of the sinus to gain an entrance and completely fill the sinus cavity. A review of the literature of the past 10 years revealed only one other similar case, attesting to the rarity of the condition.

